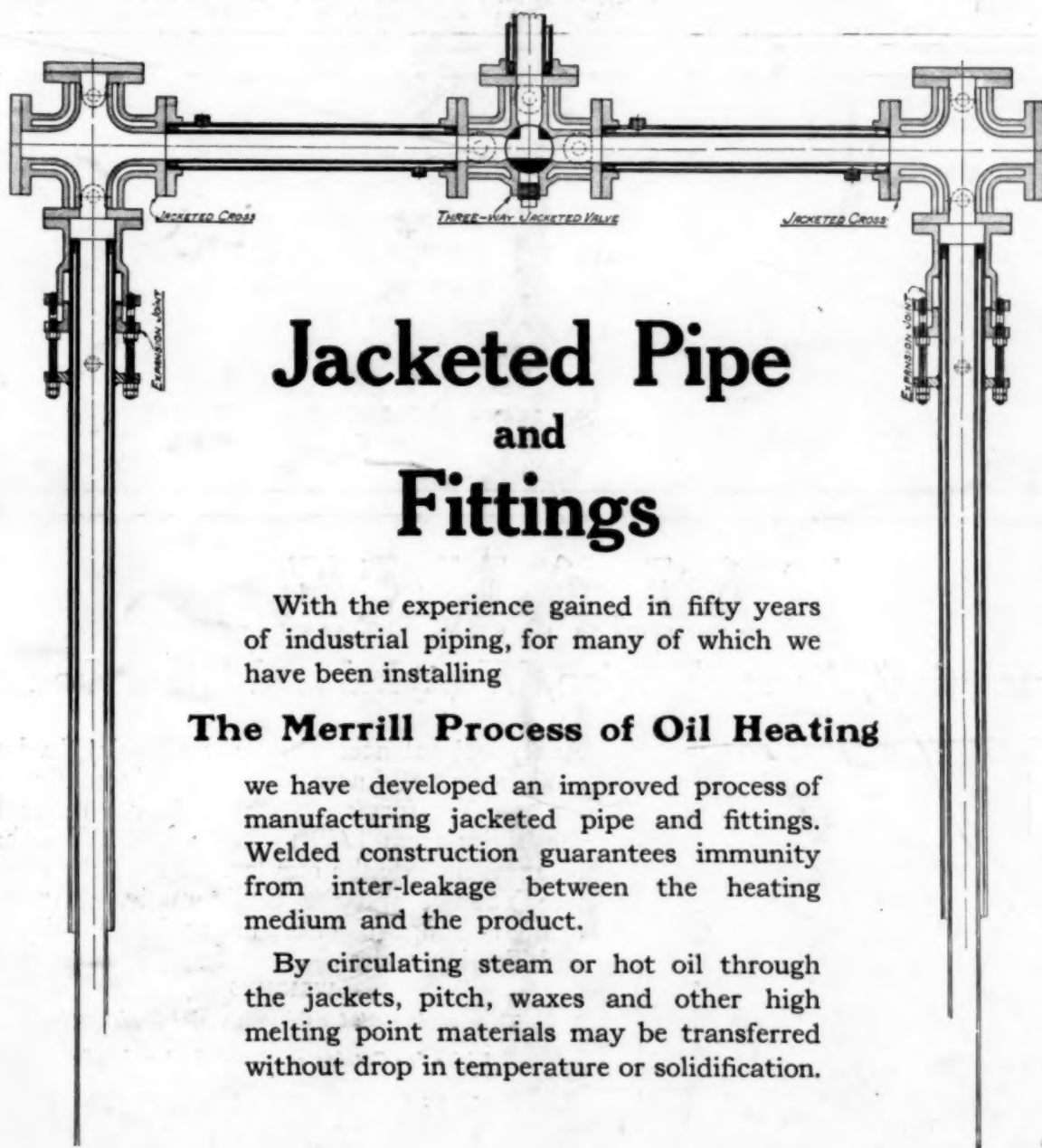


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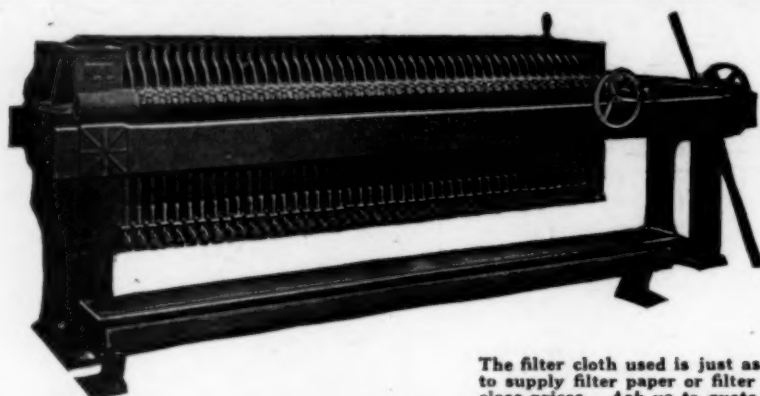
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Number 14

An Engineering Investigation Of the Muscle Shoals Project

THE decision of the Federated American Engineering Societies to make an impartial engineering investigation of Muscle Shoals and recommend what it considers the best method of handling this moot project will meet with the approval of all who sincerely want to get a fair appraisal of the relative value of the several plans that have been proposed. Shall the government construct and operate this great power development? Shall it be leased to Mr. FORD? Shall it be turned over to a private concern like the Alabama Power Co. to be developed under the terms of the federal water power act? The changes have been rung on each of these proposals, with the result that partisan groups have arisen here and there who espouse their preferences without regard to the national welfare. Hearings have been held and investigations have been made in such number that it seems unlikely that any essential facts have been overlooked.

The great problem is to study and correlate the known data and to deduce therefrom a logical plan of procedure. This is the task to which the special committee of the Federated American Engineering Societies will devote itself. If, happily, the committee can reach a decision acceptable to the country, the Federation will have rendered a great national service. Further, it will have pointed the way to the solution of other great national problems before they have run the gantlet of Congressional committees and industrial promoters. In the case of Muscle Shoals it may put a damper on the aspirations of realty companies that are promoting town lots and holding out glittering hopes of fortune to those who follow their admonition to invest immediately, but this would be a calamity under which the country will endeavor to bear up if a solution can be found for the Muscle Shoals problem.

Reaching the Wrong Conclusion

SEVERAL YEARS AGO a large manufacturing concern bought, through the medium of a banking house, an option on a certain process. The corporation paid \$10,000 for it. It was carefully worked out and ready for industrial operation. To adopt it would have involved the installation of some new equipment, but it promised material savings. Suddenly they declared that it was not what they wanted, charged up the sum paid for the option to profit and loss and would have nothing more to do with it. They would not even investigate adequately. They would not take as a gift an extension of the option; they were very drastic about it, and they "cut it out."

The process is in successful operation today, and they could easily have bought it outright and got all

their money back from royalties without even using the process themselves, if they had wanted to do so.

Now in discussion lately with the banker who negotiated the sale, he said that the incident had been very instructive to him: that he had developed from it the slogan that even 100 per cent efficiency in a laboratory test means nothing in factory practice. Of course he assumed that the purchasing and refusing corporation had acted wisely; he thought they must know their business. But right there he was wrong. The corporation had no research establishment. Nobody on the board or among its executives had technical knowledge or a chemical background for their chemical business, and what really happened was that their advisory chemist was a sick man who condemned the process without more than a cursory glance at it. The process had already been carried out on a semi-commercial scale, and the only specific reason that we could discover why it was refused with such suddenness was that the consultant didn't like the idea and it meant changes in installation. There was nobody to check off the sick man, no one to argue with him. Consequently the manufacturers made a big mistake and the banker got the wrong slant on the whole subject.

The general reason why the process was not even critically examined and the corporation lost track of the whole thing was ignorance at the top. Nobody in authority knew enough chemistry in their chemical establishment to sense the principles which underlay the process. There are plenty more of just such chemical establishments in this country.

Our Knowledge Of Coal

TWO recent developments at the University of Illinois regarding our knowledge of the character and behavior of bituminous coal are worthy of special notice. Both of these developments have been made by Prof. S. W. PARR and his associates, who have not been content to follow the well-beaten paths of fuel research, but have gone exploring in virgin territory.

In one case the work has related to the structure of coal as affected by the oxygen content of the bituminic and cellulosic constituents. In this work PARR points out that the oxygen in the bituminic constituent apparently does not affect the binding power of that material for production of coke as one would expect, but that oxygen entering the cellulosic constituent does seem to affect the coke-forming power of the coal very materially. This information brings us one step closer to an understanding of what it is that causes some coals to form no coke, some to form only soft friable coke, others to form hard, strong coke of metallurgical value.

The other investigation has been carried out by LAYNG in association with Professor PARR. It is on

the softening point of coals and the point at which the plastic coal again hardens into a coke structure. It is too early as yet to forecast what this particular investigation will demonstrate, but the results promise to be very valuable in distinguishing between the oven performance of different fuel supplies.

These two investigations are noteworthy not alone because of the results which they have given or promise to give soon. They are conspicuous rather more because they represent a pioneer effort that has been all too long postponed. Coal is the most used raw material which nature provides to industry. Half a billion tons of it are used annually. Yet after generations of use we find ourselves still with practically no knowledge of the characteristics of coal constituents and without means for thoroughly intelligent discrimination between the coal from different sources. We have been content too long to use the approximate analysis which gives us only volatile, fixed carbon, ash and moisture, and the ultimate analysis which gives us the composition by the elements—carbon, hydrogen, oxygen, sulphur, nitrogen.

The heating value of the coal and the melting point of its ash have, to be sure, been used much by engineers to judge the value of the coal for boiler firing. But heretofore we have known nothing of the other significant characteristics, particularly with respect to the coking of a coal. It is to be hoped that Professor PARR and his associates will find opportunity rapidly to extend our knowledge in the fields which they have begun to till. But these fields are only a small fraction of the virgin territory that requires exploration and mapping. Other investigators will do well to consider the general scheme of investigation which PARR is following.

An Example of The Ruling Passion

THIS HAS TO DO with an able chemist who was installed as general superintendent of an important chemical works with permission to select his own staff. The concern bought in quantity only two raw materials which were obtained under contracts, so that two contracts per year were all that were needed. Nevertheless a purchasing agent was installed who had no technical knowledge whatever, and, while he was an agreeable young man, he could not be said to be of assistance or to earn his salary. It was necessary for him to ask questions about every requisition, and that took time. It did not save money.

During the nearly two years that our friend was in charge of the plant only one director ever visited it. All that the directors knew was what they got from monthly statements. When occasional inquiries came from them involving technical points, the superintendent dictated the replies, but they were made to appear as emanating from the vice-president in charge, who was not a technical man. This was a small affair, but it misrepresented the vice-president.

The concern had a hard and fast "system" about letters. In the early days the superintendent had considerable correspondence with the sales manager to meet specifications. The product was new, and selling required no little exposition that involved technical information. Individual salesmen, interested in their work, also wrote frequently to get points, and these were answered. In time all this was forbidden. All letters were to be addressed to the company, "attention

of —" at most, and were to be placed on the desk of the vice-president before they could go out, and directions were also sent to the salesmen not to communicate directly with the superintendent. This, of course, made the letters impersonal, and it cost the company the lively interest of the sales force.

Lately some new financial interests have come in. They want to be represented in the management as well as in the directorate. So a new general manager has been appointed to care for both the business and technological ends of the company's affairs. He has no technical training. The superintendent, after bringing on his family and purchasing a house, has been dropped for no other purpose, either intimated or even conceivable, than "economy." Of course that is not of general interest, but the concern is now blundering along making what are supposed to be pure chemicals without technical direction. That is of general interest. When will our bankers learn how foolish it is to put an unprepared and unskilled man in charge of complex scientific processes, because somebody who doesn't know anything about them has "sized him up and thinks he'll do"?

Chemistry in Agriculture In Great Britain

ELSEWHERE in this issue we tell of the development of turning cellulose into humus or farmyard manure worked out at the Rothamsted Agricultural Experiment Station at Harpenden, England. It was our privilege to spend a day there with Prof. H. E. ARMSTRONG of London, who has been for many years one of the trustees of the establishment, to walk over their fields with Sir E. JOHN RUSSELL, the director, and to spend some time in the laboratories with H. J. PAGE, the chief chemist, and others. The laboratory is divided into departments as follows, with a head for each, and assistants in number from one to six: Bacteriological, botanical, chemical, fermentation, antiseptics (with insecticides, etc.), physical, protozoological, statistical, entomological and mycological. Outside is the farm with experimental fields of about 350 acres under a manager and several assistants, and inside again is the library of 15,000 volumes, with librarian and secretarial staff.

The station was founded in 1843 by Sir J. B. LAWES, and Sir J. H. GILBERT was associated with him as director for nearly 60 years. LAWES died in 1900, GILBERT in 1901 and there succeeded them in the direction Sir A. D. HALL, who resigned in 1912, and Sir E. JOHN RUSSELL, who was appointed to succeed him.

The purpose of these notes is merely to indicate work in process. Of course, there are the famous fields of wheat, barley and roots, planted year after year with the same crops—for 81 years now with wheat—and subjected to varying treatments in the way of fertilizers. The old unfertilized field will scarcely give 10 bushels to the acre this year, but usually they get about 12. In their regular wheat fields, properly fertilized, they get, as the writer recalls, an average of about 45 bushels to the acre. Standard crops are grown, along with experiments to show farmers that they can get results as well as make experiments. The British farmer trusts his eye rather than statistics. We think we have met American farmers who showed that inclination also.

In the botanical laboratory Dr. BRENCHLEY and her assistants were working among other things on the

effect of boric acid on plant growth. Hearing of the misfortunes of American farmers who got borax along with their potash, the research began to see how much of this dread poison plants can stand. Working with "broad beans" (which we take to be field beans), the curious discovery was made that they must have it! Traces of borax are found in the beans and if they are grown in a medium from which borax is entirely absent, they develop part way both in branches and roots and then stop. Roots and stalks grow nubbly and cease to mature. One part in 2½ million is enough, but one part in 50,000 is endured. More than that is likely to act as poison. Barley, on the other hand, seems to thrive without borax. The research is not completed.

The unsatisfactory results from the use of phenol as an insecticide was ground for an investigation in the biological laboratory which brought out the remarkable fact that there is a species of micro-organism that thrives on phenol as its sole source of organic matter. Another thrives on benzene, another on toluene and still another on naphthalene.

Of course, work is in progress as to the wart disease in potatoes and another research has to do with the difference in fertilizing values of chloride and sulphate of potash respectively. The Germans furnish the sulphate and claim it is better. The French produce chloride and claim that it is as good. Differences in plant cultures are observed, but definite results have not yet been obtained.

Still another study has to do with the formation of humus in soil by green manuring. The statistical department is doing splendid work in making tables showing the effect of weather on crops under the same conditions, with records that go back for 80 years.

In the soil physics laboratory work is in process to determine water-holding qualities, shrinkage, expansion, cohesion and other physical properties under given conditions. Resistance determinations by means of a dynamometer attached to a plow and measuring the draw-bar pull of chalked and unchalked land showed an increase of 150 lb. and more on each plow when the soil was lacking in calcium carbonate. This is as pretty a note in colloid chemistry as we have come across for some time.

Mechanical Equipment And Human Contentment

IN HIS ARTICLE entitled "Increased Production Efficiency Means Good Material Handling" in our issue of August 30, J. G. HATMAN said: "Some of the effects of a well-designed, efficient handling system on the personnel of the manufacturing plants are . . . it enables the employee to work at his best, and hence command a high rate of pay. It takes the burden of physical labor from the laborer and makes him a brain-worker." This is the key to contentment at work, and contentment in work is the key to industrial progress. We have often said, and we expect to continue to preach the same gospel, that no amount of profits or dividends can atone for making men of wrath and misery out of a working staff. Of course there are large numbers of men who cannot work with their brains, but if an employer cannot bother to find out which men can and which cannot use their heads at work, he is himself incompetent and would better engage someone who knows more than he does to do the job.

We recall one large establishment which, before it was injured by high finance, was a veritable haven of contentment in which the competent manager put his

stupid men into a yard gang. All that he required of them was to dig and push and pull under the direction of an intelligent foreman. That eliminated the unfit (for brain work) and yet did not throw them back on their relatives with all the distress such a procedure involves. This left him with a much higher average of intelligence for his labor staff within the works and provided that such hand workers could indeed be developed into brain workers. In order to prevent the exploitation of the unfit and the bringing down also of the fit to the same level, the labor unions have generally opposed any separation of this sort. But it is the only thing to do if highly developed workers are to be encouraged and a good esprit de corps maintained. A good man wants a chance to use his head and to improve his condition. The employer who cannot sense this and who can't provide for what the intelligent worker really needs is himself incompetent.

Productive and Unproductive Wealth

IN ROUND FIGURES the people of the United States are this year spending two billion dollars for new automobiles and three billion dollars for new dwelling houses and garages. The total of five billion is in the neighborhood of one-twelfth of the national income.

That this five billions of expenditure along these two lines is an important fact is proved very neatly by the amount of attention that has been given it. Everywhere it is being remarked that the automobile industry has had a wonderful revival; also that we are in "a great building boom." This constitutes proof that the condition is a remarkable one. Frequently the references are made for the purpose of proving a conclusion, as for instance that the country is very "prosperous." These ready-made conclusions are another matter. The point is that something big is going on.

The return for the five billions of expenditure represents actual wealth, except as it may depreciate from use or because the cost of replacement decreases. It is wealth this year just as the value of farm lands, or railroad cars, or carpets is wealth. All such items are in any proper inventory of the nation's physical wealth.

An important feature of this expenditure of one-twelfth of the national income is that it is upon property that has, in the last analysis, practically no earning power. Only to a relatively negligible extent will the automobile increase the productive power of their owners. Possibly the net result will be the other way, making the owners less disposed to work. As to the dwelling houses, their object is to increase comfort, not to increase production except as personal comfort and welfare affect production.

The great growth in the wealth of the United States has been due in large part to investment of savings in productive enterprises. The increase has been too rapid for it to represent a mere piling up of savings. The accumulation has been at something perhaps even better than compound interest. A compound interest accumulation would represent repeated investment of savings in productive enterprises.

When one-twelfth of the income is spent upon unproductive property, there is represented an abstraction from funds that would otherwise be invested in productive enterprises, in public service facilities, land reclamation, mine development and various other things. In view of this, one may well doubt whether the country is now in line to experience increases in total wealth in future comparable to the increases of the past.

Montreal Meeting American Electrochemical Society

EDITORIAL STAFF REPORT

THE forty-second general meeting of the American Electrochemical Society was held at Montreal, Canada, Sept. 21, 22 and 23. The meeting was very well attended, over two hundred registering. The local committee, headed by H. W. Matheson and C. R. Hazen, spared no effort in making the electrochemists' visit one of the most entertaining and enjoyable in the annals of the society. A. R. M. MacLean headed the excursion committee and W. B. Woodland took care of the publicity. It was largely due to Mr. Woodland's efficient methods that the convention was so well advertised and in consequence well attended.

Besides the technical sessions, there were a number of social affairs which will always be remembered by those who participated. The outstanding social event was the visit at Shawinigan Falls, where R. A. Wither- spoon and his committee were hosts. None but Wither- spoon, with his irresistible humor and very efficient leadership, could have planned and conducted that luncheon and entertainment on the lawn of the Shawinigan Falls Inn.

Thursday Morning Sessions

The technical sessions were held at the Windsor Hotel. There was much animated discussion due to a strong representation by opposing factions. The manufacturers of apparatus claimed perfection in design and high efficiency in operation; the users of this apparatus, however, were all too anxious to point out what they considered inherent weaknesses of the product. The general impression gained was that even closer co-operation than practiced in the past was needed between designer and builder of electric ovens, furnaces and other apparatus on the one hand and the user or consumer of these on the other.

The first session, Thursday morning, was opened by President C. G. Schluederberg, of the Westinghouse company. He introduced Alderman Seyboldt, who welcomed the members of the society on behalf of the Mayor of Montreal and enumerated a few of the numerous attractions of the city. It was a surprise to many to learn that Montreal had the second largest harbor in North America, constructed at a cost of over \$31,000,000. Prof. Robert Fulford Ruttan, of McGill University, past-president of the Society of Chemical Industry, extended a hearty greeting in the name of the chemists and engineers of Canada. "Your meeting in Canada," he said, "will help to emphasize the vast importance of the electrochemical industries to this country. As in the States so with us, many of the splendid researches undertaken during the course of the war have been abandoned and it requires a good deal of concerted effort to impress upon all parties concerned the absolute necessity of investigative work." Professor Ruttan's concluding remarks were: "I trust you will share with us in our good spirits."

The remainder of the morning session was devoted to

papers and discussion on electrodeposition and the properties of the products.

ELECTROLYTIC IRON

Norman R. Pilling, of the Westinghouse research laboratory, gave an account of experiments he had carried out to ascertain in what way the properties of electroplated iron are subject to modification by simple heat-treatment. The initial effect of annealing is a very marked hardening, reaching a maximum at an annealing temperature of 300 to 400 deg. C. The corresponding scleroscope hardness number is 45. At the same time the initial brittleness is removed. Annealing at higher temperature results in progressive softening, consummated above the A₁ temperature (900 deg. C.). For complete and rapid softening, annealing at 900 deg. is necessary. The rate of decomposition of the unstable iron-hydrogen compound, which is assumed to be an essential component of electrolytic iron, was observed at different temperatures.

Mr. Pilling found that the compound is actively decomposing at a temperature as low as 90 deg. C. The maximum rate of decomposition occurs at about 200 deg., but complete decomposition and expulsion of hydrogen are not achieved until the A₁ temperature is exceeded. The increase in rate of evolution above 500 deg. appears to be due to a slow release of hydrogen, by diffusion from the interior of the larger particles or crystals, rather than due to a secondary reaction. The loss in weight due to the escaping hydrogen amounted to 0.11 per cent.

A series of microphotographs were shown indicating a close relationship between physical properties and structure. The original deposits are composed essentially of closely packed needle-like crystals, generally directed perpendicular to the surface of the cathode. As

Forty-second General Meeting
Marked by Presentation and
Discussion of Papers on Electro-
lytic Iron, Electrolytic Zinc and
Electrolytic Nickel—Symposium
on Industrial Heating by Elec-
tricity — Canadians Ideal Hosts



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the annealing temperature is raised, a gradual change in structure is discernible and at 900 deg. the well-known A_2 transformation occurs.

DISCUSSION

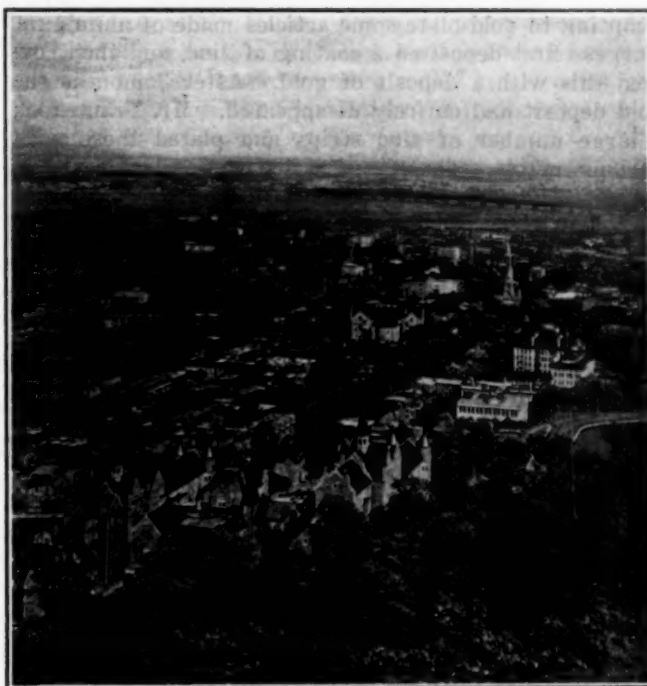
Mr. Pilling's paper was discussed and commented upon at length. Henry Howard of Cleveland suggested that it might be possible to determine the hardness of the iron-hydrogen compound. David B. Rushmore, of Schenectady, referred to the commercial development of electrolytic iron in France and inquired as to possibilities of a similar development in America. H. M. Williams, of the General Motors Research Corporation, referred to experiments on carburizing electrolytic iron deposited on worn machine parts. J. D. Alley, of Pittsburgh, pointed out that such carburizing was generally not necessary, since the deposits could be made hard enough electrolytically. Colin G. Fink, of New York, questioned whether such deposits would not be too brittle, and William Blum referred to the brittle nickel deposits due to the presence of hydrogen. Eliminating the hydrogen produced a soft flexible nickel deposit.

PREPARATION AND MECHANICAL PROPERTIES OF VACUUM FUSED ALLOYS OF ELECTROLYTIC IRON WITH CARBON AND MANGANESE

Robert P. Neville and John R. Cain, of the Bureau of Standards, Washington, next reported upon "The Preparation and the Mechanical Properties of Vacuum Fused Alloys of Electrolytic Iron With Carbon and Manganese." An extensive series of very pure alloys of electrolytic iron, carbon and manganese were prepared, the melting carried out in an Arsem vacuum furnace, thus eliminating as much as possible the influence of gases on the properties of the alloys. The ranges in chemical composition of the alloys were from 0.0 to 1.6 per cent carbon and from 0.0 to 1.6 per cent manganese. In amounts below approximately 1 per cent C the ultimate strengths of the alloys were increased by carbon, at an approximate average of 1,000 lb. per square inch for each 0.01 per cent carbon introduced. The increase in hardness due to carbon was from 1.8 to 2.6 Brinell numbers for each 0.01 per cent C, the rate being larger as the manganese contents increased. Reduction of area and elongation of pure iron were 82.5 and 40.5 per cent respectively. With the addition of carbon these values were rapidly and regularly decreased. Manganese increased the ultimate strengths of the alloys only slightly, particularly with small amounts of carbon present. Brinell hardness numbers were increased about 0.5 by each 0.01 per cent Mn when carbon was present. This rate was lower in the alloys of lower carbon contents. Manganese had very little effect on the ductility of the alloys. The effects of manganese and carbon on the mechanical properties of the alloys were each influenced by the other. The presence of C augmented the influence of Mn and *vice versa*.

DISCUSSION

In the discussion of this splendid paper, Dr. Carl Hering, of Philadelphia, referred to the carbon content of electrolytic iron as deposited. William Blum, of Washington, pointed out that this small amount of carbon was very often mechanically occluded in the deposit coming probably from the anode. However, deposits from oxalate and citrate baths contained more carbon than deposits from sulphate baths. Answering



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BIRD'S-EYE VIEW OF MONTREAL

Mr. Rushmore, of the General Electric Co., who questioned the importance and value of electrolytic iron, Dr. Hering quoted Benjamin Franklin: "What's the use of a baby?"

Electrolytic Zinc

John T. Ellsworth, of Park City, Utah, showed some very remarkable photographs illustrating the "Effects of Impurities on the Electrodeposition of Zinc From Sulphate Solutions." When manganese is present in amounts higher than 1 gram per liter, small particles of manganese dioxide remain suspended in the electrolyte and a part of these become imbedded in the zinc deposit. As these particles are saturated with electrolyte, as soon as they are covered with zinc an individual cell is formed; holes develop in the cathode which enlarge with age of the deposit. Iron present as an impurity does not deposit, but uses up current in being alternately oxidized and reduced. About 0.05 gram per liter is the maximum amount permissible. When less than this amount of iron is present, the zinc deposit is particularly smooth and bright.

Copper in excess of 0.02 gram per liter causes the formation of needle-like sprouts; with greater amounts of copper the zinc becomes black and spongy. Cadmium up to certain limits is of distinct advantage. Most of the cadmium deposits with the zinc. However, if more than 0.50 gram of Cd is present, the zinc becomes rough and black. The limiting amount of cobalt is 0.012 gram per liter. The effect seems to be something like both the high manganese and iron. The photographs show large holes in the zinc. The effect of antimony is the most serious. Less than 1 mg. per liter is permissible. In amounts of 2 mg. per liter very distinctive tree-like sprouts are formed, the efficiency is poor and the deposit is soft and spongy and difficult to melt. In the presence of both manganese and antimony, as in the ordinary plant cell solution, the permissible amount of antimony is 0.7 gram per liter.

Walter G. Traub, of the University of Wisconsin, investigated the curious phenomenon brought to the attention of Prof. Charles F. Burgess some time ago. In at-

tempting to gold-plate some articles made of aluminum, Burgess first deposited a coating of zinc, and then covered this with a deposit of gold. After 3 months the gold deposit had entirely disappeared. Mr. Traub took a large number of zinc strips and plated these with various metals. The plated strips were then placed in an electric heater at a temperature of 70 deg. for a period of 2 weeks. The specimens were then examined and it was found that thin plates of copper, brass, gold and silver diffused into the zinc, thus accounting for the disappearance from the surface. The nickel plate, however, did not diffuse into the zinc perceptibly and furthermore a preliminary deposit of nickel would prevent gold, silver and copper from diffusing into the zinc base.

In commenting upon Mr. Traub's interesting results, Harry M. Williams, of Dayton, Ohio, related his experience with copper-plated and brass-plated zinc nameplates. After a very short time the plated metal apparently disappeared. Similarly, Amos G. Reeve, of Oneida Community Research Laboratory, told of the disappearance of gold deposits on tin. R. J. McKay, of the International Nickel Co., advanced the opinion that nickel probably diffused into zinc just as did silver and gold, only there was a difference in the rate of diffusion, the nickel diffusing so much slower. He added that copper diffuses into nickel very rapidly at cherry heat. Replying to William Blum's query as to how much alloying actually took place between deposited metal and base, it was pointed out that in plating tin on iron there was little if any alloying, whereas in the ordinary tinning process by the fire method there was considerable alloying between the tin and the iron. Dr. Fink suggested that it ought to be interesting to compare the diffusion velocity of the various plated metals with the fusion curves of the respective alloys.

DE-ZINCIFICATION OF BRASS

"The De-zincification of Brass" was the title of a short paper by Ralph B. Abrams, of the University of Wisconsin. Experiments are recorded, the results of which indicate that the mechanism of de-zincification appears to be as follows: The first step is the dissolving of the brass as a whole. The copper in solution then redeposits, replacing brass as a unit. This redeposition will not take place unless there is some means of holding the dissolved copper in contact with the brass. This can be accomplished in two ways, one by the presence of a membrane, the other by having a large excess of dissolved copper present. Obviously this latter possibility is a remote one, especially so far as natural conditions are concerned. The membrane may be anything whatsoever, so long as it performs the function of keeping the dissolved copper in contact with the brass. Whether or not de-zincification shall take place can be controlled by merely supplying or taking away the membrane. Briefly, then, the de-zincification of brass is the dissolving of the brass as a whole, the holding of the dissolved copper in contact with the brass by a membrane and the subsequent redeposition of the copper.

Frank S. Weiser, of the Scovill Manufacturing Co., asked the author whether he had found any difference in de-zincification between yellow brass and red brass. Only the yellow brass had been studied. According to Mr. Weiser's experience different brasses and bronzes behave differently. Even in the low bronzes the remaining metal is all copper—no tin is left behind. Mr.

McKay, of the International Nickel Co., pointed out that in the case of Monel metal only a mere film of copper is redeposited, protecting the alloy underneath. Answering Henry Howard as to what caused the disintegration of the Monel yacht Seacall, Mr. McKay stated that this was a case of electrolytic action with the salt water as electrolyte; the stem and stern of the yacht and likewise the bolts and rivets were made of iron.

Electrolytic Nickel

The Bureau of Standards at Washington investigated "The Effect of Impurities in Nickel Salts Used for Electrodeposition." The experiments were carried out by M. R. Thompson and C. T. Thomas, and they found that of the impurities likely to be present copper and zinc are especially objectionable. On the basis of their analyses of a large number of commercial salts the following specifications are recommended:

Zinc	not over 0.05 per cent
Copper	not over .02 per cent
Iron	not over .10 per cent
Free acid	not over .10 per cent

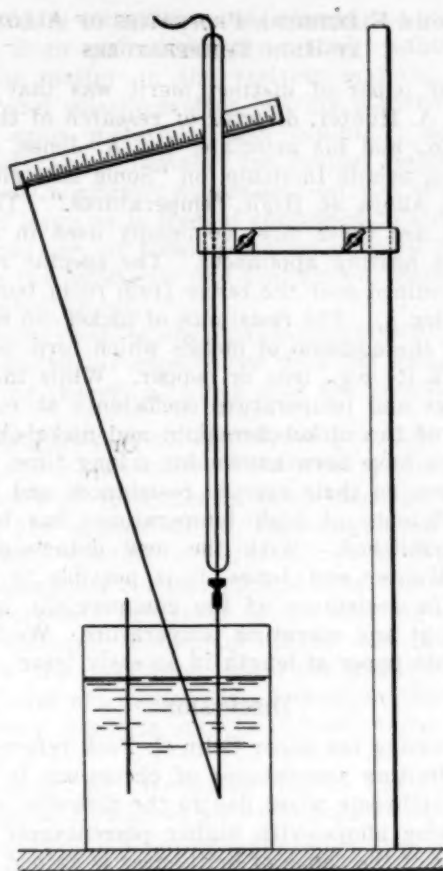
The nickel content is no criterion of the purity of the salts and is useful only in assuring that a definite amount of nickel is obtained. William Blum emphasized the fact that iron was nowhere near as objectionable as zinc and copper. R. J. McKay considered the specifications not stringent enough. In referring to the presence of magnesium in some nickel baths, Prof. Wilder D. Bancroft suggested that this impurity might well be present in the original salt.

APPLICATION OF THE CONTRACTOMETER TO THE STUDY OF NICKEL DEPOSITION

The last paper of the Thursday morning session was that of Ernest A. Vuilleumier on "The Application of the Contractometer to the Study of Nickel Deposition." The contractometer blade is a piece of sheet platinum, 6x2 cm. by 0.1 mm. thick. A narrow platinum strip is welded to the center of the bottom edge of this foil. This strip is twisted around a thin glass thread serving as pointer. The side of the foil away from the pointer is insulated by painting with vaseline. A millimeter scale, some distance above the cell, is adjusted so that the end of the glass pointer will move freely along its length (see figure). The platinum foil is immersed 3 cm.; the area plated is thereafter 6 sq.cm.

When this platinum foil is made the cathode in a nickel bath and the circuit is closed, the pointer at once begins to move toward the right. When the current is broken the pointer ordinarily stands still at once. After each measurement the nickel is dissolved in warm concentrated nitric acid, the insulation is burned off, and the apparatus is ready for a new contractometric measurement. The degree of contraction decreases when the deposit becomes more coarsely crystalline. Hydrogen, when and while electrolytically deposited, causes the nickel to expand. The contraction of the nickel is evidently a function of the size of the crystalline grains, etc., and the consequent amount of internal stress in the deposit. There are a number of factors influencing the structure of the deposit, such as metal-ion concentration, hydrogen-ion concentration, current density, temperature, etc.

In the discussion of Mr. Vuilleumier's paper William Blum agreed that it was more likely to be the crystal size of the deposit than the occluded hydrogen that de-



CONTRACTOMETER

termines the contraction. What we need now is a reliable method and apparatus to determine the degree of adhesion of electrodeposited metals. Professor Bancroft referred to his experience with platinum black used in contact catalysis. If the black is heated high enough to drive out gases, it will contract very appreciably and thereafter present a much smaller surface. However, if the platinum is precipitated on asbestos and heated, the surface exposed does not change very appreciably—the platinum particles not being in direct contact—and it is easy to obtain good reproducible results in catalytic work. The contraction of porous metals is a big problem and very little is known to date. Mr. Alley, of the Westinghouse company, emphasized the importance of absolute cleanliness in electrodeposition. If this is observed, he mentioned that he had plated rods that could be drawn through a die or forged without any apparent tendency for the deposit to peel. The plated rods were put into a pipe and bent at right angles and back again without any loosening of the deposit discernible. Heating the rods after plating the microscope did not reveal any definite line between deposit and base.

Industrial Heating by Electricity

The entire Thursday afternoon session and the Friday morning session were devoted to a discussion of the principles and practice of industrial heating by electricity. Of particular merit were the papers submitted by the General Electric Co. and the Westinghouse company. In introducing the subject E. F. Collins, of Schenectady, discoursed on "Electric Heat, Its Generation, Propagation and Application to Industrial Processes." The paper is one of the very best ever prepared on this so important subject and was received with much applause. (We expect shortly to reproduce the

greater part of Mr. Collins' paper in our columns.) The successful application of electric heat to the varied processes met in the manufacturing world involves not only a knowledge of the particular characteristics, both physical and chemical, of the process involved, but the heating device in question should be of such design as to take account of at least the laws governing the following outlined conditions, tempered with good judgment, resulting from experience:

(1) Chemical laws: (a) Chemical reactions at low and high temperatures; (b) oxidation, decarbonization at high temperature; (c) fluxing of refractories. Effect of furnace atmosphere.

(2) Mechanical laws: (a) Expansion and contraction with heat; (b) physical strength at low and high temperature; (c) crystal growth, with temperature; (d) abrasion of refractories when heated; (e) mechanical methods of construction.

(3) Physical laws: (a) Heat generation; (b) conservation; (c) transmission; (d) absorption; (e) distribution; (f) storage; (g) equalization; (h) emissivity; (i) potential; (j) diffusion; (k) quantity; (l) temperature gradients; (m) control of temperatures through control of heat flow.

(4) Laws of environment and psychology: (a) Complete knowledge of the heating process involved; (b) more or less complete knowledge of shop methods and individuals who will use the device; (c) peculiarities associated with the product to be treated or methods of manufacture should be appreciated; (d) What is the frame of mind of the operator? Will he support or antagonize a given design? (e) Do executives realize the importance of correct furnace design, and how far will they modify methods to take the fullest advantage of new and progressive equipment offered? (f) Does equipment afford better working conditions for the operator?

(5) Economic laws: (a) Covering first cost of heating equipment; (b) covering operation and operating cost of furnace; (c) covering reduction of cost of product and retaining the same quality; (d) covering increase in uniformity and quality of product and retaining the same cost; (e) greater output for same floor space; (f) reduction of labor; (g) location of equipment in the line of production, etc.

DISCUSSION

Mr. Collins' paper drew forth considerable discussion. Dwight Miller dwelt at length upon the persistent prejudice against electric heating as against gas heating due to a biased idea of cost of operation and quality of product. The user is apt to lay too much stress upon the relatively higher cost of electric power as against gas or other fuel, overlooking entirely the great improvement in quality and the increase in production. Wirt S. Scott laid stress upon the proper design of apparatus. L. E. Saunders described briefly electrical heating employed by the Norton Co.

F. A. Lidbury, of the Oldbury Electrochemical Co., deplored the lack of sufficient detailed information on the part of the manufacturer of apparatus as to the processes to be carried out in the electric heater or oven. The direct energy cost is not sufficient comparison; we must also take into account the first cost of apparatus and the maintenance cost. Too much importance has been laid by apparatus manufacturers on the efficiency of the apparatus. Often simplicity of design is much more important. For example, there are emulsion heaters sold today that are so illiberally designed that a small increase of temperature of resistor causes breakdown of the apparatus. Frederick J. Ryan, of Philadelphia, said that he had been in the business for twelve years and agreed with Mr. Lidbury that altogether too small attention has been paid to the demands and wants of the consumer. About 90 per cent of the electrical heating apparatus has been turned over to the

user for him to determine whether or not it was properly designed and suitable for his process. The consumer, and not the apparatus manufacturer, deserves the greater part of the credit in the development of electrical heating apparatus. Dwight Miller added that consumer's specifications are usually based on fuel heating practice. The consumer does not always appreciate the uniform heating with electricity as against intermittent heating with fuel. Seldom, too, has the consumer any accurate knowledge as to actual manufacturing costs. Mr. Collins agreed that it was very essential to try out the apparatus and get detailed data before approaching the consumer. Unless you can really show an ultimate economy, it is not fair to go to the consumer.

PRINCIPLES OF HIGH-TEMPERATURE FURNACE DESIGN

"Principles of High-Temperature Furnace Design" was the title of the next paper, by E. L. Smalley, manager of the Electric Heating Apparatus Co. On the basis of Mr. Smalley's experience the best electric furnaces, judged from the viewpoints of highest quality of products, lowest cost of operation and maintenance and greatest safety in operation at high temperatures, must have these attributes: Muffled type where best suited to the process. Exposed element or radiant form only when best adapted to a process. Elements of sufficient number for cheap renewal. Elements readily and easily renewable. Coils fully supported, and yet free for expansion. Refractory parts thoroughly supported, but free for expansion. No internal connections of coils should be tolerated. Terminal sizes should be larger than the element size. Source of heat must be uniformly distributed. Size of furnace must be governed by the charge. Placement of elements should not control the furnace size. Thermal efficiency should be a controlling feature in decision. Transverse section of heating elements should be round. Exposed elements preferably in corrugated grooves. Elements not chosen to suit a voltage. Total weight of heating element should be high in proportion to the weight of the charge. Efficiency of heat insulation must be adapted to the work to be performed. All of these characteristics, when properly combined with one another, will make the furnace most successful.

ADVANTAGES OF INDUSTRIAL ELECTRIC HEATING

Wirt S. Scott, manager of the industrial heating section of the Westinghouse company, contributed a splendid résumé of the "Advantages of Industrial Electric Heating." He pointed out among other things the following specific points of advantage: (1) With electric heating no products of combustion are produced that might impair the quality of the product. (2) Automatic temperature control. (3) An easier and better temperature distribution, possessing a flexibility of installation and operation not obtainable with any other form of heat. (4) Danger of gas explosions is eliminated. (5) Electric heaters respond quickly when the current is turned on and have a sufficient temperature head to force the heat quickly into the work.

In complimenting Mr. Scott upon his paper President Schluederberg referred to the distinct progress made in industrial heating due to the introduction of the electric apparatus. It is necessary only to see once the large enameling ovens in Detroit to appreciate what wonderful possibilities have been opened by electric heating as compared with fuel heating.

SOME ELECTRICAL PROPERTIES OF ALLOYS AT HIGH TEMPERATURES

Another paper of distinct merit was that of Prof. Matthew A. Hunter, director of research of the Driver Harris Co., and his associate, Dr. A. Jones, of Rensselaer Polytechnic Institute, on "Some Electrical Properties of Alloys at High Temperatures." The alloys discussed are those most commonly used in electrical ovens and heating appliances. The specific resistance was determined over the range from room temperature to 1,000 deg. C. The resistance of nickel can be readily raised by the addition of metals which form solid solutions with it—e.g., iron or copper. While the specific resistances and temperature coefficients at room temperature of the nickel-chromium and nickel-chromium-iron alloys have been known for a long time, no exact information on their specific resistances and temperature coefficients at high temperatures has been previously published. With the new data supplied by Messrs. Hunter and Jones, it is possible to calculate the specific resistance of the commercially important materials at any operating temperature. We intend to publish this paper in length in an early issue.

DISCUSSION

In discussing the paper Colin G. Fink referred to the present limiting percentages of chromium in the two types of nichrome wires due to the difficulty of rolling and drawing alloys with higher percentages. As our knowledge of the cause of brittleness is gained, it seems safe to predict that sooner or later we may be able to produce resistance wires with as much as 40 or even 60 per cent of chromium present. The influence of other elements, such as carbon, silicon, etc., although investigated from time to time, is not yet fully appreciated. On the other hand, it was pointed out by Professor Hunter and Frank S. Weiser that nichrome brought into contact with asbestos, mica or other silicates at high temperatures will produce brittleness at the point of contact. E. F. Collins discussed the relative merits of nichrome ribbon as against nichrome wire. He considered the ribbon better for most purposes.

RESISTIVITIES OF SOME GRANULAR RESISTOR CARBONS

Clyde E. Williams, of the Bureau of Mines, and Gordon R. Shuck, professor of electrical engineering, University of Washington, Seattle, reported their determinations of the "Resistivities of Some Granular Resistor Carbons." Granular resistor materials are used in the heating elements of some types of electric furnaces. The important requirements of a satisfactory resistor material are: Small change in resistivity with different temperatures in order to avoid too much regulation of current; a low ash content to obviate too frequent renewing of heating element; high resistance to oxidation; sufficient density, physical strength and hardness to withstand mechanical forces tending to break up particles. Williams and Shuck find that at 1,000 to 1,200 deg. C. the difference in resistivities of the various types and sizes of carbon resistors is not very large. The temperature coefficient of resistivity is negative for all the forms of carbon tested up to 1,000 or 1,200 deg. C., at which temperature it approaches zero and then becomes positive as the temperature increases further. This change was more pronounced in graphite than in the other forms of carbon.

The resistivity increases as the size of the particle decreases. High resistivities are caused by the presence of volatile matter in the resistor material, the resistivity and volatile matter bearing a direct relation for the same material. Ash contained within the particle of carbon increases the contact resistivity and the thermal coefficient somewhat, but the effect is not nearly so large as is that of contained volatile matter. Extraneous ash or foreign matter of high resistivity increases the resistivity and the thermal coefficient to a very marked extent.

The paper was briefly discussed by Dwight Miller, who recounted his experiences with the Baily furnace, the heating element of which is of the granular type.

HEAT-INSULATION MATERIALS FOR ELECTRIC HEATING APPARATUS

A subject of fundamental importance is the proper selection and application of "Heat-Insulating Materials for Electric Heating Apparatus." J. C. Woodson, of the Westinghouse company, has studied this subject for many years and presented to the meeting a detailed report, including numerous curves and photographs. Although the insulation materials available for low temperatures are more or less numerous, there are few satisfactory products on the market today for high temperatures.

Discussing Mr. Woodson's paper, Carl Hering, of Philadelphia, mentioned his experience of whitewashing the outside of his furnace and thus very perceptibly improving the heat insulation. Upon compressing a porous insulating material, the heat flow through the material at first decreases, but upon further compression the heat insulation value drops off rapidly. Dr. Hering strongly recommended the use of the thermal ohm, as it saves a good deal of calculation. Prof. Alfred Stansfield of McGill University emphasized the importance of avoiding too thick a layer of outside insulating materials, such as Sil-o-cel, especially in high-temperature furnaces. The melting point of Sil-o-cel and similar materials is comparatively low and if all the heat is trapped, it soon accumulates in the inner layers, a temperature approaching that of the bath is attained and the Sil-o-cel melts. Similarly it does not pay to make the roof of the electric steel furnace too thick. Frank W. Brooke, of the Electric Furnace Construction Co., mentioned the case of using 4½-in. Sil-o-cel as outside insulation which started to fuse after ten heats. Replying to Henry Howard of the Graselli company as to the advantages of using air spaces at definite intervals between the layers of brick or asbestos, Mr. Woodson said that above 300 deg. C. air spaces are of no advantage on account of the convection currents. There undoubtedly would be some advantage were these spaces evacuated.

FIRING OF CERAMICS IN ELECTRIC FURNACES

E. L. Smalley discussed the "Firing of Ceramics in Electric Furnaces." The cleanliness of atmosphere, the uniformity of temperature control and the ease of duplication of temperatures have made the electric furnace very adaptable to the china and glass industries. L. E. Saunders, of the Norton Co., pointed out that a commercial process for the electric firing of grinding wheels has not yet been worked out. Organic binders for these wheels require but 100 to 200 deg. C. and wheels with the sodium silicate binder are not heated above 250 deg. C. Professor Bancroft con-

sidered a small high-temperature electric furnace for porcelain firing a very desirable and welcome piece of apparatus. Artists could then fire their own china and thus we would encourage the development of artistic decorative china. The art would no doubt develop to heights never attained before. Frank W. Brooke and F. A. J. FitzGerald agreed that there are wonderful possibilities along this line of porcelain firing, but who is to pay for the development of such a small electric firing furnace especially designed for artists' use?

OTHER PAPERS

With the aid of an interesting set of slides Frank W. Brooke described in detail "Methods of Economically Handling Materials in Electric Furnaces." In some instances the work was carried through the furnaces on cars, in others the work was attached to an endless chain, and in all cases provisions were made to conserve as much of the heat as possible.

Wirt S. Scott gave a detailed account of the "Development of Industrial Electric Heating for Low-Temperature Enameling" and described the enameling ovens used in the automotive and typewriter industries.

The concluding paper of the symposium on industrial heating was presented by C. B. Gibson, of Pittsburgh, on the "Electric Annealing of Malleable Iron." Very little has been done along this line and developments are very much in the experimental stage. There are many advantages of electric annealing as against annealing in fuel-fired furnaces. Among others there is the elimination the packing pots, stacks, flues, stokers, etc., and considerable saving in labor.

Simple Electric Crucible Furnace for Melting Aluminum

The final paper of the Friday morning session was a short report on the construction and operation of an electric crucible furnace, by Prof. A. Glynn Lobley, director of the electrochemical laboratories, Victoria University of Manchester. The crucible, which will hold 40 kg. of aluminum, is heated by means of a resistor of nichrome ribbon 6.3 mm. wide and 1 mm. thick. An aluminum alloy containing 8 per cent of copper was melted in the crucible, and in an average week 465 lb. was melted with an energy consumption of 363 kw.-hr. The voltage across terminals was 200. Full details of construction were given.

Electric Steam Generators

P. S. Gregory, of the Shawinigan Water & Power Co., described the improved type of electric steam generator developed by F. T. Kaelin, chief engineer of the company. The water-resistance electric steam generator consists essentially of a closed pressure vessel to which is connected a source of water supply and from which water may be drawn off at the bottom and steam at the top. In this vessel electric energy is made to flow through the water from an electrode in the form of a plate or tube, to the shell of the vessel, or to the metallic inner lining. Alternating current energy is used at a pressure varying from 110 up to 12,000 volts. The generators are constructed for the use of three-phase power, either by employing three electrodes in one vessel or by the use of three vessels with one electrode in each, in which case the outer shells are connected together in star. In this type of generator there is no

heating surface, the generation of steam taking place throughout the water, and as a consequence no portion of the apparatus is at a higher temperature than the temperature of the steam. This is a most important feature from the viewpoint of safety and continuity of operation, as can be readily appreciated.

The chief advantages of the water-resistance type of steam generator over the metallic resistance type are freedom from electrical and mechanical troubles, ease of regulation and cheapness.

There are in operation in Canada and in the United States at the present time installations of electric steam generators totaling about 150,000 kw., which are for the most part installed in paper plants.

DISCUSSION

Mr. Gregory's paper drew forth a long, animated discussion. F. A. Lidbury, of Niagara Falls, who has had considerable experience with the electric steam generators, commented upon the importance of studying the conditions and requirements of each individual mill or plant. The rising coal prices have done much in popularizing electric steam. Dwight Miller referred to successful installations in various paper mills. Eric A. Lof, recently returned from a trip to Sweden, reported that hundreds of electric steam boilers are in daily use in Europe, largely operated on surplus power. Why not do away with many of the coal-fired steam boilers in this country and introduce the electric steam accumulators? In Europe there are forty-two successful installations of that kind. Dr. Carl Hering inquired whether any appreciable decomposition of the water were discernable, due to electrolysis. Philip H. Falter, of the Canadian Electro Products Co., replied that very little is known regarding any electrolytic effects, but it has been observed that electrodes wear out entirely out of proportion to the energy consumed. Furthermore, with twenty-five-cycle current there is greater electrode wear than at sixty cycles. Mr. Lof cited a Swiss case where very low cycle current was used and dissociation of the water took place. Others who participated in the discussion were Duncan MacRae, of the Westinghouse company, Acheson Smith, of the Acheson Graphite Co., and Wilder D. Bancroft, of Cornell University.

A New Induction Furnace

J. Murray Weed, of the General Electric Co., gave a detailed account of a new induction furnace. In this furnace, as in other induction furnaces, the heat is produced by an electric current induced by transformer action in a looped portion of the molten charge, which we will call the secondary. This secondary is distinct from the melting chamber pot, in which the cold charge is received, melted and held for refining and pouring. The success of the furnace depends upon a continuous, automatic circulation of the molten metal between the secondary and the melting pot, to prevent overheating in the former and to deliver the heat to the cold metal in the latter. It is in the form of the secondary, and in the character of the circulation and the method of producing it, that the new fundamental features of this furnace are found.

The circulation in this furnace is effected by the force of electromagnetic repulsion, set up through the medium of the magnetic leakage field, which exists between primary and secondary in any transformer. This force is proportional to the square of the current flow-

ing, and is familiar to all transformer engineers as having caused much trouble in the wrecking of transformers when the windings were not held with sufficient rigidity to withstand the enormous forces of this nature which are set up when short circuits occur.

The induction furnace is, in fact, a special case of a short-circuited transformer, in which the internal impedance is comparable with the total full load impedance of the secondary circuit of the ordinary transformer. The repulsive force in this furnace, therefore, is not excessive, as in ordinary transformers when short-circuited, but only such as exists in ordinary transformers when normally loaded.

DISCUSSION

Oscar Brophy, of the Ajax Metal Co., referring to the circulation of metal in the Weed furnace, said that the method of producing this circulation is not new, because it was described by him in the U. S. Patent 1,296,752 granted March 11, 1919. He felt that the flow of metal in the Weed furnace depended upon two facts: (1) There is an electrodynamic force of repulsion between the primary and secondary as their currents are in opposite directions. (2) This force is given an axial direction, so as to cause the metal to flow up into the bath, by means of the axial displacement of the primary. Dr. Hering likewise felt that there was no new principle involved in the furnace described by Weed. John A. Seede, associated with Mr. Weed, considered the furnace a radical departure. Mr. Weed added that the furnace is still in the experimental stage.

Carbon Bisulphide

George A. Richter, of the research laboratories of the Brown company, has carried out a detailed investigation of the electrical production of carbon bisulphide. We expect to publish this paper shortly in full.

Preparation of Perchlorates by Heating Chlorates

Frank C. Mathers and J. W. H. Aldred carried out experiments seeking to increase the yield of perchlorate by heating chlorates. But no variation in the conditions of heating chlorates and no catalysts were found whereby the yield could be increased. A maximum yield of about 55 per cent perchlorate was obtained by heating 1 to 50 grams potassium chlorate for 30 to 60 minutes at 480 to 540 deg. C. Most substances, when added, decreased the yield. The sodium chlorate gave a smaller yield. There seems no possibility that the chemical preparation of perchlorate from chlorate can equal the electrolytic method.

Electrosmosis and Electrophoresis

Oliver C. Ralston, in his paper, proposed the terms "electrosmosis," "electrophoresis," "cathodophoresis" and "anodophoresis" (1) to replace a large number of other words, some of which are incorrectly used and all of which are awkward; (2) to gain uniformity of nomenclature in conformity with the two words "electrolysis" and "electrostenolysis," and (3) to provide single descriptive nouns, which when properly modified can be used as verbs, adjectives or participles that easily displace present clumsy phrases.

Electrolytic Oxidation of Isoeugenol

Prof. Alexander Lowy, of the University of Pittsburgh, is an ardent enthusiast for the electrolytic preparation of organic chemicals, and at the Montreal

meeting he reported upon one of his latest researches, that on isoeugenol, which he had carried out jointly with Miss C. M. Moore. The first part of the investigation here reported dealt with the method for the preparation of vanillin as described in the German patent D.R.P. 92,007. It was found that the specifications of the patent are not exact, in spite of statements to the contrary appearing in many textbooks. Repeated tests gave rise to no appreciable amounts of vanillin—a resinous substance being obtained instead. Perhaps derivations of isoeugenol, such as the acetyl or benzoyl, could be used to produce the desired results. Further investigation is desirable.

Insulating Compounds

The two concluding papers of the Friday afternoon session dealt with insulating compounds. The first of these was by Dr. H. C. P. Weber, of the Westinghouse company, on the "Changes in the Electrical Conductivity of Varnishes During Drying" and the second by Dr. C. J. Rodman on "Arc Action on Some Liquid Insulating Compounds." Both subjects are of great importance. There are many intricate problems presented in the study of insulating compounds and it takes the closest co-operation of chemist and electrical engineer to hasten a solution of these problems.

Social Features

So much had been planned by the local committee in social entertainments that it was difficult to find time to take in even a small fraction of these. Thursday evening was spent at McGill University and the members had the pleasure of listening to a scholarly discourse on "The New Philosophy of Physics" by Dr. A. S. Eve, a physicist of world-wide repute. The experiments were exceptionally well planned and carried out. Golf enthusiasts spent a number of delightful hours at the Kanawaki and Royal Montreal Golf Clubs. All of the outings arranged for the ladies were carried through to perfection under the able and clever guidance of Mrs. C. R. Hazen. There were automobile and coach sightseeing tours; a very sumptuous tea on the lawns of the Royal St. Lawrence Yacht Club; an equally enjoyable gathering at the Engineers' Club; a theatre party; and finally the ladies joined in the excursion to Shawinigan Falls.

Shawinigan Falls

An exceptionally attractive and enjoyable feature in the program was the all-day outing to Shawinigan Falls. Special coaches reserved for the society were attached to the midnight train, arriving at the Falls early Saturday morning. The local members, under the most able leadership of R. A. Witherspoon, gave the visitors a cordial reception. Automobiles were in readiness to take the party to various plants of interest. At the Shawinigan Water & Power Co.'s plant opportunity was afforded to inspect a new horizontal unit in the process of installation. As F. T. Kaelin had pointed out, Shawinigan Falls is an ideal place for water-power development and the manufacture of electrochemical products. Not only is there an available high head and a large quantity of water with fairly constant flow, but the St. Maurice River widens into a lake just above the falls, and after making a sharp bend forms a second lake 145 ft. below. This brings the upper and lower water levels within a short distance of each other, thus



POWER DEVELOPMENT AT SHAWINIGAN FALLS

providing an extremely economical location for the power plant at the bottom of the slope between them. Part of the power used at the Falls for the manufacture of carbide, carborundum, aluminum, electrodes, acetic acid, paper and other products; a large portion of the power is transmitted to Montreal.

CANADA CARBIDE CO.

At the Canada Carbide Co.'s plant the visiting electrochemists saw the large 6,000-kw. carbide furnaces in operation. These furnaces are about 10 ft. high with a base about 10x10. The two electrodes are 48 in. wide, 16 in. thick and about 7 ft. high. They are built up of three electrodes each, 16x16 in. square, the seams being carefully luted. The voltage of the carbide furnaces is kept constant at 125 to 130 volts and the amperage is about 30,000 per phase. The electrodes have a life of about 10 to 12 days, operating 24 hours a day. The feed consists of two parts of limestone to one of coke; the carbide is tapped at intervals, the tapping temperature being about 1,000 deg. C.

BELGO PAPER CO.

At the Belgo Paper Co.'s mill one of the novel features was a 25,000-kw. electric steam generator. There are three iron cylindrical units, star-connected and operating at 6,600 volts. An iron cylinder next to the shell forms the one electrode and a cast-iron perforated pot about 18 in. in diameter and 16 in. high is concentrically suspended and forms the second electrode. Kaelin electric steam generators are also installed at the Laurentide Pulp & Paper Co.'s mills. These have a maximum capacity of 70,000 kw., or 7,000 boiler horse-power.

A complimentary buffet luncheon was served on the lawn of the inn. This luncheon was the outstanding social event of the meeting. How much it was enjoyed and appreciated by the members and guests is difficult to realize. A most generous and entertaining host, with a capacity for efficiency seldom equaled saw to it that a delicious and spirited luncheon was served with remarkable dispatch and comfort to all. The good humor and cordiality of hosts and guests alike, made for an abundance of good will and happiness. Robert Turnbull, A. T. Hinckley, Howard C. Parmelee and R. A. Witherspoon took turns as song leaders, introducing new verses and variations in many of the electro-thermic ballads and electrochemical ditties so familiar to all members of the society. This closing event of the Montreal convention seemed more like a happy family reunion than a staid convention of learned men. The members returned in a body to Montreal, and soon after all were on their way home.

Electrolytic Iron From Sulphide Ores

AN ESTIMATION of the commercial possibilities of electrolytic iron in America was given by F. A. Eustis in a paper read Sept. 27 before the Mining and Metallurgical Society of America. He recounted briefly the various laboratory investigations which have been published during the last 50 years, and described the experiments he and his associate Charles P. Perin have been making.

COMMERCIAL OPERATIONS IN FRANCE

Their interest was revived by the use of electrodeposition to build up worn steel parts¹ (a process adopted by the allied armies) and the undoubted commercial success of the Société le Fer at Grenoble and two or three other localities in France.² Founders of the latter enterprise took out their first patents in 1910. As is perhaps well known, their product is iron boiler tubing, deposited on a rotating cathode, 4 m. long. Soluble cast-iron cathodes are used, the current density is in the neighborhood of 100 amp. per sq.ft., led in through the rotating mechanism. Their tanks are located somewhat above the floor; electrolyte is distributed through an overhead pipe and rubber hose connections. It overflows to a sump, from which it is pumped to a tank containing iron turnings. This performs a double purpose: it keeps the solution both reduced and filtered. Air is blown into the electrolyte to absorb hydrogen—as deposited the iron is somewhat brittle from hydrogen, but a gentle annealing drives off the gas and renders the metal extremely ductile. A high speed of rotation of the cathode was thought to be very important—it was maintained at a correct rate by observing a pilot electrode consisting of a cone rotating at known speed.

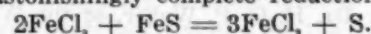
The Grenoble plant produces about 1½ tons of boiler tubes per day, ready for the market after stripping from the cathode, cutting to length and slight annealing. Variation in gage amounts to no more than 0.002 in., plus or minus. The iron is very pure; it is quite soft so that it is easily expanded into its connections. Its superior thermal conductivity increases the efficiency of the boiler, and its resistance to corrosion enables it to resist the pitting action of many waters.

SOME IRON IS MADE IN ILLINOIS

Only one American firm is now making electrolytic iron in commercial quantities: the Western Electric Co. has a plant at Hawthorn, Ill., producing about 2 tons per day.³ Its tank house looks much like a copper refinery. Brittleness of the deposit is here a virtue; the iron is knocked off the polished steel cathode, ground in a ball mill and tumbled with zinc dust (thus coating each particle). The powder is then compressed and made into cores for loading coils for telephone installations, for which it has been found to be peculiarly advantageous.

Iron of Extraordinary Purity Is Made From Pyrite, Recovering Sulphur as a Byproduct—Costs Will Be Low Enough Not to Handicap Wide Use of the Metal

In experimenting with some complex Cuban iron ores⁴, Perin and the author decided to use SO₂ from pyrite as a reducing agent for their chloride solutions, but it was found that the pyrite residue contained as much iron as was recovered from the process. Consequently it seemed logical to use a sulphide ore not only as a reducer but also as an ore. As a matter of fact, pyrrhotite (the monosulphide of iron) dissolves easily in ferric chloride, giving an astonishingly complete reduction:



This reaction is exothermic, producing about 700 B.t.u. per lb. of iron dissolved—an important advantage, since successful electrolysis appears to demand hot solutions.

Ground pyrite (FeS₂) is not as good a reducer as pyrrhotite, only 60 per cent of the metal going into solution before the residue is insulated by a sulphur deposit. Pyrite may be easily changed to pyrrhotite by a reducing roast; flowers of sulphur or brimstone is a byproduct of more value (at present market prices) than the cost of the operation. In view of the tremendous amount of nearly pure iron sulphide (one Spanish mine alone has 100,000,000 tons developed) to say nothing of the vast tonnages of complex sulphides carrying attractive amounts of gold and silver, it appears to Mr. Eustis that the most of our future electrolytic iron will come from these sources, and this idea forms the basis of his patented processes.

PURIFICATION OF ELECTROLYTE

The process, as is now in operation in their experimental mill at Milford, Conn., consists of grinding the sulphide and agitating the pulp with spent electrolyte (containing FeCl₂ and FeCl₃ in equal molecular proportions). Sulphur and other insolubles are filtered.

Any copper in the ore goes into solution, but it is precipitated very cleanly and easily on metallic iron. (In passing it may be remarked that this may prove to be a more economical process for the recovery of copper from lean pyritic ores than the present methods of selective concentration and smelting, wasting all the iron, either in a mill tailing or in a blast-furnace slag.) Zinc and cadmium may be taken out of solution as a sulphide, precipitated either by H₂S or a soluble alkaline sulphide. (After about 9 months' experimentation, the Consolidated Mining & Smelting Co. at Trail, B.C., has been able to make iron sheets of most excellent quality, and containing 0.04 Zn, from a zincy pyrrhotite tailing.) Other impurities are not expected to give much trouble, since we have learned how to make solutions of extraordinary purity in our struggles with electrolytic zinc. Iron solutions do not appear to require such extreme purity. Furthermore, iron sulphide is so widespread that if one ore gives trouble, another could usually be substituted. In large-scale work, the operator would doubtless bleed a moderate amount of solution from the circuit in order to keep certain accumulating impurities within bounds. This would involve a loss of its chlorine,

¹"Building Up Worn Metal Parts by Electrodeposition," by W. E. Hughes, *Chem. & Met.*, vol. 26, p. 267 (Feb. 8, 1922).

²Jean Escard, *Le Génie Civil*, Aug. 23, 1919.

³*J. Am. Inst. Elec. Engrs.*, July, 1921, p. 598.

⁴Some of this work was described by Carle R. Hayward, in *Chem. & Met.*, vol. 26, p. 261 (Feb. 8, 1922).

but it would probably be replaced with gas made on the spot, given cheap power and salt.

DETAILS OF DEPOSITION

The diaphragm cell used is much like a caustic soda cell. It contains graphite anodes. As iron is deposited from FeCl_2 in the cathode compartment, the chloride migrates through the diaphragm to the anode and oxidizes two molecules of ferrous chloride. The solution in this compartment is circulated so that it never reaches a greater concentration than 70 grams per liter of FeCl_2 (and about the same of FeCl_3). This prevents free chlorine from giving trouble in the solutions and atmosphere, and from lowering the electrical efficiency.

When conditions are right, iron is deposited at high current efficiency, exceeding 95 per cent. That is to say, 1 gram of iron may be had per ampere-hour. The amount per kilowatt-hour depends of course on the resistance of the cell, which in turn depends upon the composition and temperature of the electrolyte, but most especially on the current density. For instance, other conditions being equal, a current density of 20 amperes per square foot requires 1 volt, 40 amperes 2 volts, and 160 amperes 4 volts. Therefore if a plant can operate 90 per cent of the time, and power costs \$20 per kilowatt-year (a figure at which large blocks have been offered), one ton of iron can be produced for \$2.40 worth of current at 1 volt, \$4.90 at 2 volts and \$9.80 at 4 volts. Part of the saving in power when operating at low voltages would be offset by higher overhead charges on account of the more extensive plant needed. Power costs of not more than \$5 per ton compare favorably with the cost of coke for blast-furnace iron.

Many difficulties must be met before ferric chloride solutions can be handled in large volume. Most of the equipment at Grenoble was made of wood, it being quite resistant and easy to change. They are now rebuilding permanently in concrete—probably of a special nature. Sulphur resists hot FeCl_3 very well indeed, and it will doubtless be used to a great extent, either pure or as a cement for silica sand. Pumps may be located in the reduced portion of the cycle. Stoneware pumps will doubtless give very good results—rubber-lined pumps also have possibilities.

COMMERCIAL POSSIBILITIES

Physical properties of the deposited iron have been summarized by Bradley Stoughton⁵. Its purity, ductility, rust-resisting properties and high thermal and electrical conductivity fit it for a number of special uses, to which it will be welcomed and which will furnish the early market. Thin boiler tubes, fine iron wire, deep stamping stock, cold-worked parts of precise shape and electrical or magnetic specialties are attractive possibilities. Such uses might easily absorb $\frac{1}{4}$ million tons of iron a year. A similar or even greater tonnage will undoubtedly be absorbed by the manufacturers of crucible and superfine electric steels for tools and high-strength alloys, if the cost could be kept somewhat below that of Swedish iron, or the price of selected scrap plus the necessary refining costs.

ESTIMATES OF COSTS

All these possibilities depend upon the cost of the iron. Certainly the ore will not be a limiting factor. As indicated above, there is a great wealth of pyrrhotite

available, which can be had, ground, for \$5 or \$6 per ton. These ores are of such a nature that no costly difficulties from impure solutions need be expected. At present market prices, the sulphur recovered is worth more than the ore will cost, so for the time being the raw iron will be free. Of course a great tonnage of electrolytic iron from this source will glut the sulphur market. (The United States' annual consumption is now not more than 1,500,000 tons of sulphur, which would be produced as a byproduct from 3,000,000 tons of iron. New uses of sulphur may be found, but any important tonnage, such as for concrete, could carry only a very low price.)

Labor and supplies are quite high in plants now operating. This is due in great measure to the small scale of the operations and the semi-experimental nature of the work. As a matter of fact, Mr. Eustis sees no factor which would demand permanently high costs for labor and supplies. The electrolytes must be kept hot, but careful calculations show that this is a problem of insulation, since both the reducing and the deposition reactions generate quite large amounts of heat.

Electric power in this country from water or coal is unlimited, its development only awaiting a market. Certainly the cost for electricity will always compare favorably with the fuel cost in a blast furnace. Operating voltages are very low, and all the electrical details for an electrolytic refinery have long since been worked out.

Capital cost may be balanced against the power cost. An expensive large plant may operate on little power at low voltage, or a smaller plant can get the same output with greater power. Mr. Eustis thinks, however, that capital charges may fall within \$8 to \$12 per ton of iron produced.

In closing, the speaker gave the opinion that the possibilities of the process are great, although the road ahead is far from easy.

Corrosion of Rifles

A source of great loss, not only to the national defenses but to every owner of a firearm, is the slow corrosion which gradually destroys the accuracy of fire, even when every effort is made to protect the rifling by cleaning the barrel and keeping it well oiled. This "after-corrosion" under an oil film has been studied by the Bureau of Mines. The experiments were performed on the U. S. Infantry rifles and ammunition, using the high-pressure smokeless cartridge primed with typical fulminate, sulphocyanide and sulphur compositions.

Smokeless powder leaves behind no nitrocellulose residue (except when the pressure developed is relatively low, as in firing blank cartridges), nor does it leave a corrosive acid residue. After-corrosion in this instance is due to a water-soluble salt (KCl) from the decomposition of the chlorate in the primer. This salt is retained in pits or minute chatter marks in the bore, from which it cannot be removed by wiping. However, the salts easily dissolve in water, even condensing it from the atmosphere below the dew point, and corrosion proceeds by reaction with atmospheric oxygen. The trouble will disappear when a primer containing no chlorate may be developed.

Meantime, after-corrosion may be suppressed by washing in naphtha and then in hot water, carefully drying, oiling and then keeping both ends of the bore tightly corked. Many non-aqueous compositions recommended for cleaning firearms possess little or no value.

⁵The Iron Age, Jan. 5, 1922; Chem. & Met., vol. 26, p. 128, Jan. 18, 1922.

The Air Bleaching of Nitric Acid*

An Experimental Study of the Bleaching of Nitric Acid With Air—Effect of Temperature, Air Velocity, Etc., Discussed and Analyzed—A Formula Is Derived for Calculating the Bleaching Coefficient Which Is Checked by Experiment

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THE problem of bleaching nitric acid to be used in the manufacture of mixed acid has assumed greater importance as the specifications on lower oxide content have become more rigid. This has stimulated the development of better methods of operating and controlling the bleaching process which is necessary in the older types of plants. This paper presents the results of experimental work on bleaching nitric acid at varying temperatures and air rates, and develops a theory and an equation whereby these results can be applied to industrial practice.

Removal of Lower Oxides. The process of bleaching strong nitric acid with air consists essentially of volatilizing the lower oxides present and removing them by the current of air. There are, therefore, three important factors involved. In the first place, the vapor pressure of the lower oxides, determined by their concentration and the temperature of the solution, is a direct measure of their tendency to volatilize. Next, a source of heat is necessary to supply the heat of vaporization. Finally, the volatilized oxides must be removed from the system—a process which is effected in this case by a current of air. These three factors will be discussed separately.

First Factor: Vapor Pressure of Lower Oxides. Owing to the relatively low concentration, the vapor pressure of the lower oxides at any given temperature may be assumed to be directly proportional to their concentration in the solution (Henry's Law)—i.e., $p = \alpha N$ where p = the partial pressure of lower oxides, N = the concentration of lower oxides in the solution (expressed as per cent N_2O_5) and α = the proportionality constant. It is obvious that α will vary with the temperature of the solution, and, by analogy with other cases, an exponential function may be predicted.

Second Factor: Heat of Volatilization. The major source of heat is the solution itself, which cools during the bleaching process. It is, of course, possible to supply heat externally and prevent cooling, but this does not alter the concept. It is impracticable to supply much heat in the air used for bleaching, since the sensible heat of the air stream is necessarily small compared to the total heat required for evaporation.

Third Factor: Mechanical Removal of Vaporized Oxides. The air used to remove the volatilized products could theoretically become saturated in an ideal bleaching pot. Actually, this condition is nearly realized, so that an approximation that the air reaches the same percentage saturation under different conditions of temperature and velocity is justified. The oxide removal should, therefore, be nearly proportional to the air rate, varying only by slight differences in the saturation of lower oxides at different air velocities.

The bleaching formula derived from these considerations is as follows:

$$-\frac{dN}{d\theta} = \beta N$$

Where N = per cent N_2O_5 in solution

θ = time in minutes

β = the bleaching coefficient, defined as the drop in per cent lower oxides per minute in a 1 per cent solution.

$-\frac{dN}{d\theta}$ = the instantaneous rate of bleaching.

The above equation states that the rate of removal of the lower oxides is a function of the amount of oxides present. This equation integrates to the form

$$\log_e N = -\beta\theta + \text{constant}$$

or, between the limits of an initial concentration N_1 and a final concentration N_2 ,

$$\log_e \frac{N_2}{N_1} = -\beta(\theta_2 - \theta_1)$$

The coefficient β is not a constant, but varies with the temperature of the solution and the air rate, and should be nearly proportional to the latter. All laboratory runs were made with constant temperature and air rate, so that β was itself constant for any one run. It is obvious that the validity of the theory and assumptions given above must be demonstrated by comparing the equation to actual data obtained in bleaching runs.

The absence of data on the vapor pressure of lower oxides has made it impossible previously to calculate the rate of bleaching. In this work it has been considered that the actual vapor pressure obtained from laboratory bleaching runs is the vapor pressure of oxides above the solution. This is not strictly true, since, as noted previously, the air does not become saturated. However, the approximation that the same degree of saturation is reached in all cases permits this assumption and, furthermore, such vapor pressure data are applicable to other bleaching runs in which complete saturation is again unattainable.

Loss of Nitric Acid. During the removal of lower oxides, nitric acid will itself be volatilized, but the problem is somewhat simplified in that the vapor pressure of nitric acid remains constant during a run at any one temperature, since the amount vaporized is so small. Although data on the vapor pressures of HNO_3 in concentrated solutions at higher temperatures are a little uncertain, it is possible to calculate the values from data at lower temperatures using the Clapeyron equation. These values may be compared with observed values.

The experimental work consisted in bleaching nitric acid on a laboratory scale under various conditions of temperature and air rate. Compressed air was passed through a calibrated flow meter and then to a 2-liter bleaching flask, where it was distributed in the acid by

*Paper presented at the meeting of the American Institute of Chemical Engineers, Niagara Falls, N. Y., June 19, 1922.

†Assistant Professor Chemical Engineering Practice, Massachusetts Institute of Technology.

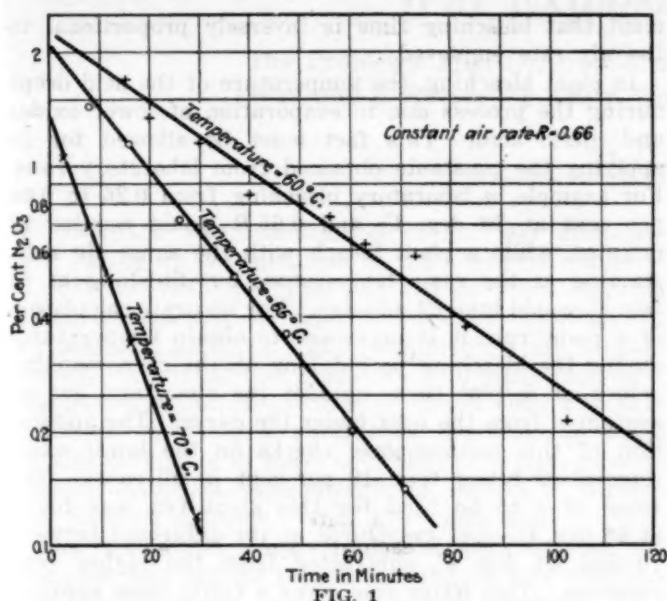


FIG. 1

a perforated glass coil. The flask was equipped with a thermometer, a gas burner for heating and an exhaust tube for the gases, which also acted as an air-cooled condenser. The amount of nitric acid lost during the process by evaporation was measured by collecting the condensate.

Each test consisted of bleaching 1.5 liters of raw acid (93 per cent HNO_3) at a definite temperature and air rate. At intervals during the bleach acid samples were siphoned from the flask and analyzed for dissolved lower oxides of nitrogen by titrating a diluted sample with tenth normal KMnO_4 ; the oxides being expressed as N_2O_3 . Approximately 200 c.c. of the acid was removed as samples, giving an average volume of 1.4 liters.

The first set of three runs was made at constant air rate, equal to 0.66 liter air per minute per liter of acid, and temperatures of 60, 65 and 70 deg. C. respectively. Air rate is expressed as the ratio of air volume per minute per unit volume of acid, so that the results would be comparable with plant practice. The second set of three runs was made at constant temperature—namely, 70 deg. C., and air rates of 0.51, 0.66 and 0.75 liter per minute per liter of HNO_3 , respectively.

If the original equation $\log_e N = -\beta\theta + \text{constant}$ is true, then plotting $\log_e N$ against β should give a straight line whose slope equals $-\beta$.

Fig. 1 shows log of the lower oxide concentration plotted against the time of bleaching for runs at three different temperatures, but at a constant air rate. The points for a given run all fall close to a straight line,

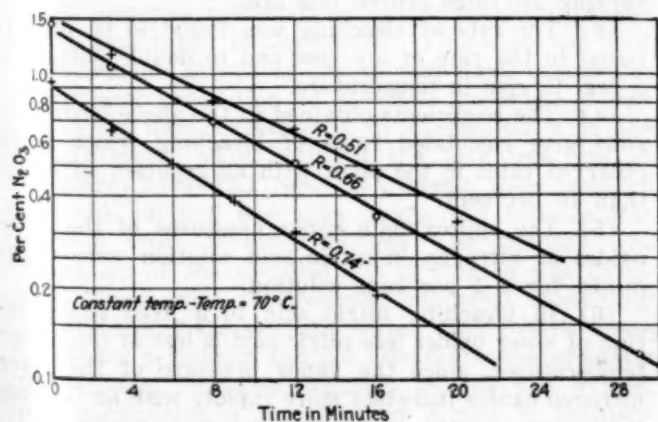


FIG. 2

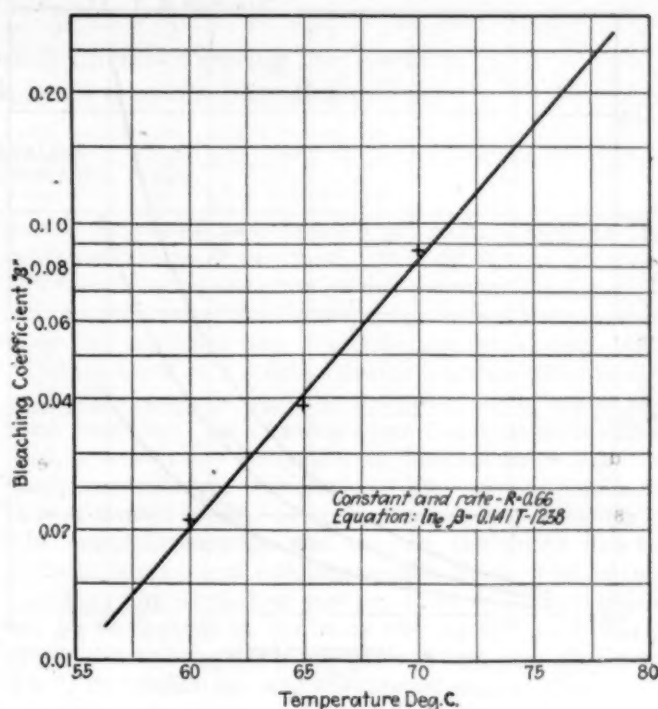


FIG. 3

thus verifying the original law for rate of bleaching. Fig. 2 shows the log of the lower oxide concentration also plotted against time of bleaching for runs at three different air rates, but at a constant temperature. These points for a given run, all falling close to a straight line, again verify the original equation.

The slope of each line on Figs. 1 and 2 equal the bleaching coefficient, $-\beta$, for that specific temperature and air rate, as seen from the equation above.

The variation of β with temperature at constant air rate, Fig. 3, is represented by an exponential function as predicted, since the vapor pressure vs. temperature relation in general is exponential. An inspection of Fig. 3 shows that the log of β when plotted against temperature gives a straight line and that the rate of bleaching doubles every 5 deg. C. The equation showing the value of β with variation in temperatures is $\log_e \beta = 0.141 T - 12.38$.

The rate of bleaching is nearly proportional to the amount of air used, Fig. 4, the line failing to pass through zero due to incomplete saturation of the air at the velocities in question. The equation showing the variation of β with air rate is $\beta = 0.0122 + 0.112 R$. Fig. 5, showing the combined effect of temperature and air rate on the rate of bleaching, is self-explanatory.

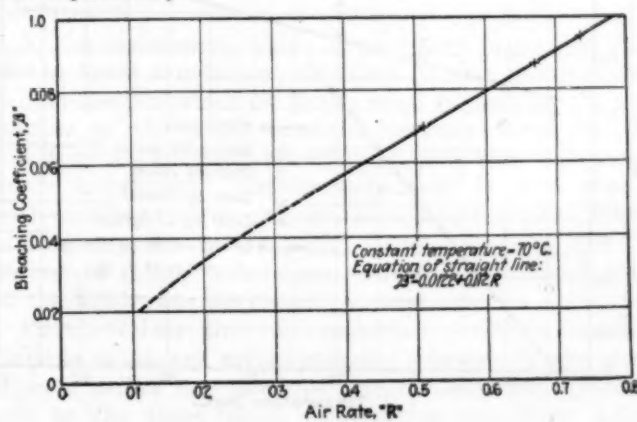


FIG. 4

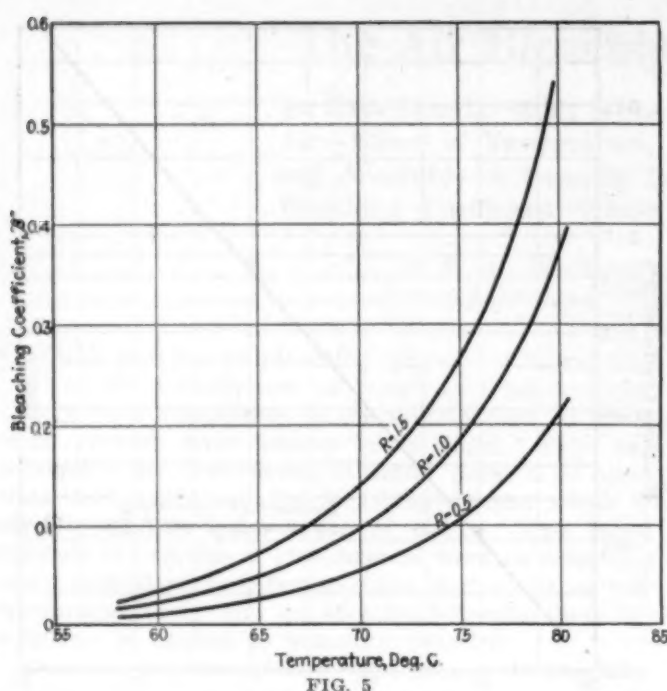


FIG. 5

Fig. 6 shows vapor pressures of nitric acid and lower oxides above 93 per cent nitric where the lower oxide concentration is 1 per cent. The values calculated by extrapolating data¹ by means of the Clapeyron equation and those experimentally determined points are compared with data by Pascal² and Creighton and Githens.³ The lower oxide vapor pressures are admittedly low, due to incomplete saturation of the air, as already noted. This plot shows the lower oxide pressure for a 1 per cent solution, and Henry's law may be used to calculate the pressure above a solution of any other concentration.

These results indicate the advantages to be gained by using a high temperature. An inspection of the integrated equation, $\log_e \frac{N_1}{N_2} = \beta(\theta_2 - \theta_1)$, shows that bleaching between any two concentrations N_1 and N_2 requires a time inversely proportional to β , the bleaching coefficient. Since β doubles with a 5 deg. C. rise in temperature, bleaching time at 40 deg. C. therefore would be sixty-four times as long as at 70 deg. C. The effect of air rate may be simplified to the state-

¹Thorpe, vol. 3, p. 692.
²Paul Pascal, *Ann. Chim.*, vol. 15, pp. 253-90 (1921).
³H. J. M. Creighton and J. H. Githens, *J. Frank. Inst.*, vol. 179, pp. 161-9 (1915).

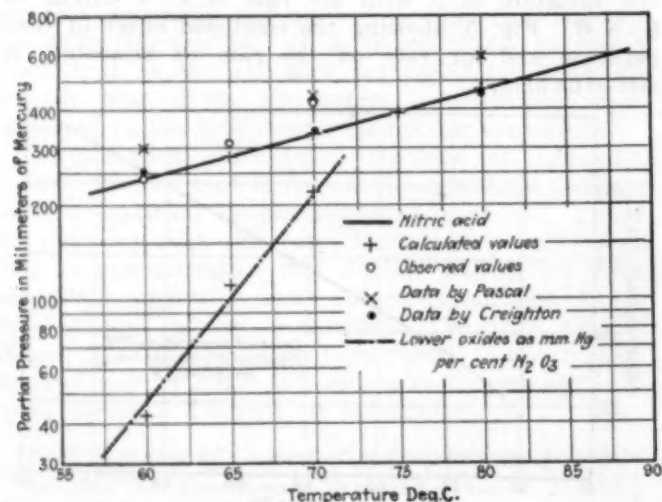


FIG. 6

ment that bleaching time is inversely proportional to the air rate employed.

In plant bleaching, the temperature of the acid drops during the process due to evaporation of lower oxides and nitric acid. This fact must be allowed for in applying the constants obtained from laboratory runs. For example, a laboratory bleaching from 0.26 to 0.06 per cent at 70 deg. C. and 0.66 R would require 18 minutes, while a plant bleach with the same air rate, starting at the same temperature but finishing at 64 deg. C. would take 32 minutes. For accurate calculation of a plant run, it is necessary to obtain temperatures during the bleaching period, look up the corresponding values of β , plot these against the time, and get an average β from the area under the curve. The application of this method gave checks on the lower oxide removal of better than 10 per cent in all cases. The value of β to be used for this plant run was found at 66 deg. C.—i.e., two-thirds of the difference between 70 and 64 deg. C. subtracted from the higher temperature. This latter rule gives a fairly close approximation in all cases, so that it is unnecessary to use the accurate method mentioned above. Thus, in bleaching an acid high in lower oxides dropping from 70 to 55 deg. C., the average value of β would be 60 deg. C.

Bleaching may be effected by merely heating the acid, providing the vapors have opportunity to escape from the system. It is possible to raise the acid to such a temperature that the lower oxides boil off, the boiling point rising as the oxide content decreases. Some work has been done along this line with the object of determining the optimum combination of heating and air blowing to give the desired bleaching, having in mind the loss of nitric acid, the heat requirements and the time necessary. The results of this work will be published at a later date.

The loss of nitric acid incurred in bleaching has been calculated from the vapor pressure data shown by the line on Fig. 6. While the results are not strictly quantitative, it can be stated that, in bleaching to a fixed concentration, less nitric acid is lost at the higher temperatures. This statement is corroborated by Fig. 6, where the lower oxide vapor pressure increases with temperature much more rapidly than the nitric acid pressure.

SUMMARY

(1) From theoretical considerations, the equation for the rate of bleaching of nitric acid by air is shown to be

$$\log_e \frac{N_1}{N_2} = -\beta(\theta_2 - \theta_1)$$

(2) Three runs at constant air rate but varying temperatures and three runs at constant temperature but varying air rates proved this law.

(3) The rate of bleaching was found to be proportional to the rate of air flow and to double with each 5 deg. C. rise in temperature.

(4) The coefficients obtained in the above laboratory runs give calculated rates of bleaching which check observed rates in the plant with an accuracy of better than 10 per cent.

(5) The approximate vapor pressures of the lower oxides of nitrogen in nitric acid solution were determined for a 1 per cent solution.

(6) In bleaching nitric acid to a fixed concentration of lower oxides less nitric acid is lost at the higher temperatures, since the vapor pressure of the lower nitrogen oxides increases more rapidly with an increase in temperature than does the vapor pressure of HNO_3 .

War Explosives in France

The Problems That Confronted French Chemists During the World War and a Review of Their Work in Developing New Explosives

BY J. CAVALIER

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FRANCE was handicapped in her war manufacturing by the situation in her chemical industry. It has been said that she had no great chemical industries and that she depended on other countries for her chemical products. This statement is not strictly correct, for France was independent in many instances, manufacturing an abundance of dilute sulphuric acid and even exporting a number of important products such as carbonate of soda, chlorides, chlorates, mineral coloring materials, superphosphates, essence of turpentine, tanning extracts, soaps, glycerines, etc.

The fact is that a real division of work between the countries had become established and in this distribution the industries based on organic synthesis were practically monopolized by Germany. Particularly was this true with respect to the aromatic compounds, especially dyes, for which, like most other nations, France was tributary to Germany.

Now it happens that the industry of coloring materials is closely related to that of nitro-explosives. A country which is fitted out to make the first is fitted out to make the second, for it has available the aromatic hydrocarbons, raw materials common to both industries. In France the production of coal was never above the immediate need of the country and consequently relatively few coke ovens were operated and many of these were not of the byproduct type. Therefore the production of benzene and toluene at the beginning of the war was altogether insufficient for the demand.

REGULATION EXPLOSIVES AT OUTBREAK OF WAR

At the time war was declared the regulation high explosives used in France for charging artillery projectiles were TNT, picric acid and trinitrometacresol. As the war went on, new projectiles came into use, such as hand grenades, trench mortar bombs, airplane bombs, etc., so that the demand rose from about 40 tons a day at the beginning to 1,064 tons. The raw materials for such large-scale production were lacking; it was necessary to find, study and use other explosives that could be substituted for these.

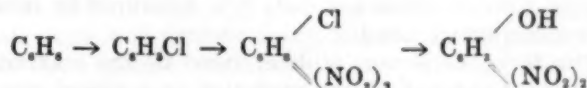
SOLVING THE PROBLEM

The situation called for relief either by increasing the development of natural resources, by the utilization of new raw materials or by the development and use of new types of explosives. Following the first two expedients, strenuous efforts were made to increase the national production of essential materials. New coke ovens were constructed in connection with the blast furnaces, which utilized the new iron ore of Normandy; byproduct recovery systems were installed in all the old and new coke plants and benzene was recovered from illuminating gas. In addition, the rectification of the so-called oils of Borneo was developed. These oils are complex mixtures containing hydrocarbons of the aliphatic series, analogous to those of ordinary petroleum and not nitratable, and aromatic hydrocarbons, including benzene, toluene and xylene. Their composition is variable, but it may be approxi-

mately expressed as benzene 5 per cent, toluene 13 per cent and xylene 7 per cent. The extraction of these substances in a pure state is not commercially feasible, but by successive rectifications the aromatic hydrocarbons are enriched and fractions are separated, each of which contains a single nitratable hydrocarbon mixed with non-nitratable aliphatic hydrocarbons of about the same volatility. By treating these fractions with nitric acid, a mono-nitro derivative is formed which may be easily separated by distillation. The mononitrotoluene thus separated is used as raw material for making TNT. The mononitrobenzene was used in the production of aniline, dyes and diphenylamine, the well-known stabilizer for smokeless powder. The mononitroxylene can be trinitrated in the same way as toluene to form xylite and although this explosive is less powerful than TNT, its utilization was considered and studied.

Another hydrocarbon which had not been used in France up to this time for war explosives, and of which notable quantities could be obtained, was naphthalene, $C_{10}H_8$. The mono-, di- and tri-nitro derivatives were prepared, each of them, as a matter of fact, being a mixture of isomers rather than a definite chemical compound.

Picric acid, the second-mentioned regulation explosive, is the trinitro derivative of phenol. Some work was done in the early days of the war in preparing the dinitro derivative directly from benzene without the intermediate phenol stage. Benzene is transformed into a mono-chlor substitution derivative by passing a stream of chlorine through it in the presence of iron filings, which act as a catalyst. By nitration, dinitro chlorobenzene is obtained; the chlorine is relatively mobile and the OH group can be easily substituted for it by saponification with caustic soda, which gives the dinitrophenol.



The dinitrophenol obtained was then by a further nitration to be transformed into picric acid. However, as it was possible to procure the necessary phenol elsewhere, the latter part of the operation was abandoned and the dinitrophenol was employed directly in the mixtures.

As for metacresol, which is necessary in making one of the three regulation explosives, it was not possible to increase the stock on hand; even by uniting the resources of the allied countries scarcely more than a few tons a day could be obtained, and this was absolutely insufficient. Trinitrometacresol is used mixed with melinite for the purpose, as will be described later, of lowering the fusion point. The same rôle can be played by other substances, especially dinitrophenol, so the latter was developed to some extent.

Thus, besides the raw materials formerly used—benzene or phenol, metacresol and toluene—it was possible to utilize two new ones, naphthalene and xylene; and to the three usual nitro-explosives—picric acid,

TNT or toluite, and trinitrocresol—were added xylite, mono-, di-, and tri-nitronaphthalene and dinitrophenol. The study of certain derivatives which had been investigated and proposed for certain purposes was also resumed: trinitro-anisol, trinitrophenetol, tetranitromethylaniline and hexanitrodiphenylamine.

All these derivatives involved about the same raw materials and hence did not increase the sum total of the country's resources. Moreover, their explosive properties were not such as to warrant undertaking new and complicated methods of manufacture. Hence they were not extensively developed. Instead, attention was directed to two other types of explosives, the nitrates and the chlorates. Considerable quantities of ammonium nitrate were available from the synthetic plants of Norway, and Chilean nitrate was also being imported. The manufacture of chlorates, especially sodium chlorate and ammonium perchlorate, presented no difficulties.

The third-mentioned expedient for relieving the chemical situation—that of developing and using new types of explosives—therefore followed these lines. A large number of available mixtures can be made by mixing the various substances mentioned above, the nitro derivatives, nitrates and chlorates. The problem would have been relatively simple had there been only the questions of resources and production methods with which to cope. But there were other factors to reckon with. While almost any of the combinations can be applied indiscriminately for explosives used in mining operations, this is not true for those employed in charging shells, where the safety factor is of such great importance. Besides, the effect to be produced must not be overlooked, as a different type of shell is required for use against troops than that used to break up trenches or to destroy barbed wire entanglements. Again, the method of charging and the available apparatus for this operation had to be kept in view.

Fundamental Properties of Explosives

In developing a new explosive the essential properties to be considered are its potential energy, its force, its sensitiveness and the speed of detonation.

The potential is the total amount of heat evolved by the reaction in a closed vessel; it is measured by means of a calorimetric bomb.

The force, or power, is determined by the maximum pressure developed by the explosion in a closed vessel, and is measured by means of a pressure bomb, a strong hollow cylinder of steel closed at one end by an electric firing device and at the other by a "crusher" gage. The pressure developed is transmitted to a copper cylinder and is measured by the amount of compression sustained by the cylinder.

For a given explosive, the pressure evidently increases with the "density of the charge"—that is, the weight of explosive per unit of volume. It is not proportional to this density, for it must become infinite when the volume occupied corresponds to the smallest volume which the products of decomposition (gases and solids, if such are formed) can have, however great the compression to which they may be subjected. This smallest volume per unit of weight is called the "co-volume"; it is the volume below which the decomposition products of 1 kg. of the explosive are not compressible.

Let α be the co-volume.

π the weight of the explosive charge.

V the volume occupied.

The pressure P is related to the charge by the equation:

$$P = \frac{f\pi}{V - \alpha\pi} \quad (1)$$

or, substituting the density of the charge $\Delta = \frac{\pi}{V}$

$$P = \frac{f\Delta}{1 - \alpha\Delta} \quad (2)$$

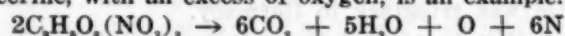
f is a constant for each explosive and characteristic of the force. It is the pressure produced by 1 kg. of explosive decomposing in a closed space equal to 1 cu.dm. plus the co-volume. In fact, if we put $\pi = 1$

$$\text{and } V = 1 + \alpha$$

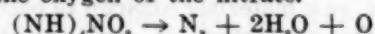
in formula 1, we find $P = f$

With powerful explosives this force is of the order of 7 to 10,000 kg. per square centimeter. It depends on the quantity of heat and the amount of gas furnished by the decomposition.

Certain nitro- or nitrated explosives contain sufficient oxygen to transform all their carbon into carbon dioxide and all their hydrogen into water. The nitrogen is supposed to remain in the free state. Such explosives are said to be completely combustible. Nitroglycerine, with an excess of oxygen, is an example.



Such also is the case with ammonium nitrate explosives, such as schneiderite; the quantity of dinitronaphthalene has been adjusted so as to be completely burned by the oxygen of the nitrate.



This does not apply to all explosives, however. Nitrocellulose has approximately the formula $C_{12}H_{10}O_{10}(NO_2)_8$, or $C_{12}H_{10}N_8O_{22}$. To give $12CO_2 + 7H_2O$ it would require $24 + 7$, or 31O, whereas we have but 22. Picric acid is $C_6H_3N_3O_9$. The molecule contains 7O, while complete combustion would demand 12 plus $3/2$.

Hence, when these compounds decompose, considerable amounts of carbon monoxide are formed which can poison the air in the dugouts. With picric acid there may be a considerable amount of carbon liberated, producing a black smoke. However, the completely combustible compounds are not always the most efficacious. For example, the nitro derivatives of the picric acid class, far as they are from complete combustion, are generally more powerful than the mixtures of the schneiderite type. In the new mixtures studied during the war it was those which by incomplete combustion would yield carbon monoxide that were chiefly sought.

For nitro derivatives of the same type, the power increases as the ratio of the number of nitro groups to the number of carbon atoms in the molecule. Thus, trinitrotoluene, $C_6H_3(CH_3)(NO_2)_3$, is more powerful than the dinitro compound and more powerful than trinitroxylene, $C_8H_3(CH_3)_2(NO_2)_3$.

SENSITIVENESS

The greater or less ease with which an explosive substance detonates when subjected to friction or shock is its sensitiveness, a quality of capital importance which merits consideration, not only in regard to use of the explosive but also for handling it during the process of manufacture and in transportation. A very simple experiment will give a clear conception of its nature. A metallic weight is permitted to fall from various heights on a small quantity of the explosive in a capsule. The minimum distance through which the weight may be

dropped and still produce detonation is a measure of the sensitiveness of the explosive. Fulminate of mercury is extremely sensitive, while ammonium nitrate mixtures and picric acid are much more resistant to shock and friction. The salts of picric acid, however, particularly the alkali picrates and lead picrate, are extremely sensitive.

For a given explosive, the sensitiveness depends to a certain degree on its physical condition. It is greater in a mass of crystals which can rub against one another and it is diminished by making the mass more compact, especially by fusing and hindering the formation of larger crystals during subsequent cooling. It is also lessened by imbedding the crystals in a plastic substance which separates them. Thus melinite is imbedded in paraffine to render it less sensitive to rough handling.

VELOCITY OF DETONATION

Certain more sensitive substances detonate on being lighted. Such is always the case with lead picrate and mercury fulminate. The latter is used as a primer; the explosion wave produced by the detonation of a very small quantity of fulminate (about 2 grams) is transmitted to the explosive to be detonated. If this should not suffice, as in the case of resistant explosives, a relay is employed which consists of a certain quantity of explosive of medium sensitivity. The detonation must spread throughout the whole mass of the explosive.

The speed with which the detonation spreads through a given explosive is not a constant; it varies with the amount of tamping. A very simple method due to a French engineer, Dautriche, enables us to determine the relative velocity of detonation as compared with a standard velocity, that of a rod or string of melinite. The explosive under investigation is placed in a metallic tube *T* about 10 cm. long. At two well-defined points *B* and *C* are the ends of a strip or cord of picric acid, *BCD*. Each of these ends is provided with a charge of fulminate. The explosion is initiated by a third fulminate charge at *A*. The wave travels to *B* and then to *C*. The strip of explosive is laid out on a plate of lead; the two explosion waves originating at and traveling from *B* and *C* move in opposite directions through the strip and at the point where they meet produce a transverse furrow at *E*.

If the two fulminate caps *B* and *C* were discharged at the same time, the furrow would be made at the midpoint *D* of the strip, a point which is marked exactly at the beginning of the experiment. A slight lag between the detonation of *B* and *C*, however, will cause a dis-

placement of the furrow to *E*. This displacement, *DE*, is measured carefully and will be represented by *e*. The distance between the two caps *B* and *C* is also measured and called *l*.

Let *L* = length of strip *BD*.

v = the velocity of the detonation to be measured.

V = the velocity of detonation in the strip.

The times of travel of the two explosion waves *BDE* and *DCE* are equal. Therefore,

$$\frac{L + e}{V} = \frac{l}{v} + \frac{L - e}{V}$$

$$\text{or} \quad \frac{2e}{V} = \frac{l}{v}$$

Whence

$$\frac{v}{V} = \frac{l}{2e}$$

The velocity *V* in the cord of melinite as measured by a direct method is about 7,000 meters per second. The maximum velocity of detonation of nitro explosives lies between 6,000 and 7,500 meters per second; that of schneiderite and other nitrate explosives between 5,000 and 6,000 meters; that of chlorate explosives between 3,500 and 5,000 meters.

DENSITY LIMIT

Let us study a nitrate or chlorate explosive under different degrees of tamping or compression. Untamped, the material has generally but a low velocity of detonation: it increases with tamping and hence with the density up to a certain degree of compression, beyond which it diminishes rapidly and the detonation is no longer transmitted. The density corresponding to the maximum velocity is called the "density limit" under the conditions of the experiment. This point is of great importance, for if, in charging, this limit is overstepped, the explosive could not be detonated.

The density limit has not a fixed value for a definite explosive; it increases with the dimensions of the receptacle and the resistance of the containing walls. Thus, in the open air, schneiderite will not detonate unless its density be somewhat greater than 1; in a tube of copper, 2 cm. in diameter and with a wall-thickness of 1 mm. similar to those used in the method of Dautriche, the density limit is 1.45 to 1.50; it is over 1.50 in a 75-mm. shell and 1.6 in a 155-mm. shell.

Nitro explosives (picric acid, tolite, etc.) have, so to speak, no density limit; the velocity of detonation only becomes irregular as a result of great compression—4,000 kg. per square centimeter (density 1.7).

The properties and determinations described form the basis for the choice of explosives for producing any desired effect. For shells to be used against troops the charge should break the envelope into a large number of fragments which will act as so many separate projectiles. Therefore a very powerful explosive is required and a very sudden detonation. The nitro explosives fill this requirement admirably.

On the other hand, there is no need of great velocity of detonation to destroy trenches, power and potential energy being the qualities desired. Nitrate explosives which are slower, and some of which evolve more heat, will often do more effective work on the ground than nitro explosives.

For mining operations a great variety of formulas may be used. It is quite feasible to control the charging density to give the desired detonation.

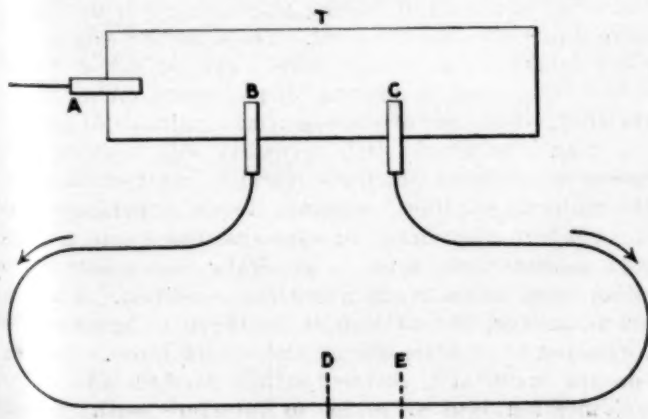


DIAGRAM OF APPARATUS FOR TESTING VELOCITY OF DETONATION

The use of explosives in projectiles, especially in projectiles for artillery of high initial speed, presents other important problems. The velocity of such a projectile rises from 0 to 500 meters per second in about 0.01 second. Besides, it generally takes a rotary motion. The effect of inertia on the explosive contained in the shell will have a tendency to produce friction between the particles and consequently ignition and premature explosion followed by rupture of the gun or at least serious damage.

For use in projectiles the charge mass must be stable and free from any tendency to shift or become displaced. To this end it is necessary that the material be compact, without open spaces after the charging, and have no tendency to form them at the firing of the shot. At that instant, the interior charge is pressed against the base of the shell with a force that can readily be conceived. The phenomenon is called the set-back.

If S be the exterior surface of the base of the shell, P the maximum pressure produced by combustion of the powder, the force acting on the shell is PS .

Let M be the mass of the shell, G its acceleration.

Then $PS = MG$.

Let p be the weight of the shell and g the acceleration due to gravity.

Then $p = Mg$

Whence $PS = p \frac{G}{g}$

$$G = g \times \frac{PS}{p}$$

Calculation shows that the acceleration G of the projectile is greater the smaller the caliber. For a 75-mm. shell, G equals 17,000 g . That means that the charge, as well as each part of the shell, at the moment of starting, weighs about 17,000 times its ordinary weight. By multiplying the acceleration by the total weight of explosive and dividing by the cross-section of the interior, we obtain approximately the pressure to which the layer of explosive on the base is subjected. This is called the pressure due to the set-back. In the 75-cm. shells its maximum value is about 900 kg. per sq.cm. Under this pressure the explosive material is compressed to a density which we may determine by subjecting a small portion of the explosive to the same pressure in a cylindrical mold and measuring the density of the compressed mass. The preliminary tests must necessarily be verified by density measurements made on charged, but unprimed, projectiles that are actually fired. A surcharge of propellant is employed to give the desired margin of safety. The unexploded shell is recovered, opened and the density of the charge at the base is measured.

This is the density that must be reached in charging. If not, it will be reached in firing the backward displacement of the charge toward the base which, as we have said, might cause a premature explosion. The density thus determined and which must be realized in charging is then compared with the "density limit" of the explosive—that is, the density beyond which the detonation is no longer transmitted. If the "density limit" has been overstepped, the explosive under investigation must be abandoned for the caliber intended.

To realize these necessary conditions—low sensitivity, compactness, sufficient density—two methods of charging are employed: Compression and fusion.

The shell is filled with the powdered explosive and rammed down by hydraulic pressure. This process pro-

duces compact charges, but is too slow for intensive production. Picric acid shells were loaded this way, a mixture of 88:12 picric acid:paraffine being used. The paraffine incloses the crystals reducing the sensitiveness and gives the necessary plasticity for the compression without hindering the detonation, the latter being accompanied by a fulminate primer and a relay of picric acid crystals properly tamped. This combination was used for shells of medium and large caliber.

AMMONIUM NITRATE EXPLOSIVES

Since 1888, the Service des Poudres had manufactured an explosive composed of 87.5 per cent of ammonium nitrate and 12.5 per cent of dinitronaphthalene for use in mining operations. This explosive, on complete combustion and sudden decomposition, yields a large volume of gas, the final temperature of which is not very high so it is a safe explosive for use in mines where firedamp prevails. It was not employed by the French artillery, but had been utilized by the Schneider company to charge projectiles which it sold to foreign countries and which were used especially in the Balkan war. Hence the name "schneiderite," by which it is known. Thus it was an explosive that had been studied, had been tested for war purposes and had given satisfaction. One of its drawbacks was the fact that ammonium nitrate is hygroscopic and the explosive must be protected from moisture.

An analogous but more powerful mixture consisting of 77 per cent ammonium nitrate with 23 per cent xylite was also used. Sodium nitrate may be substituted for the ammonium salt, although it produces a smaller volume of gas and forms an explosive with less shattering power than schneiderite; but for large caliber shells and for clearing ground it gives satisfactory results.

TABLE I—COMPOSITION OF PROJECTILE EXPLOSIVES

Constituent	Per Cent									
	87.5	77	70	80	85	50	50	50	50	50
NH ₄ NO ₃	87.5	77	70	80	85	50	50	50	50	50
NaNO ₃	1.25	..	..	..	10	30	30	30	30	30
Dinitronaphthalene.....	..	..	..	20	..	20	..	..	15	15
Trinitronaphthalene.....	..	23	..	..	..	..	20	..	5	..
Xylite.....	..	..	30	..	5	..	..	20	..	5
TNT.....	..	..	..	..	..	..	..	..	..	..

Of the new combinations tried and tested, a number were considered satisfactory and held in reserve. These formulas are summarized in Table I.

CHARGING IN FUSED STATE

Most of the explosives charged in this way are nitro compounds either alone or in mixture. The explosive is melted in a bath of boiling water or glycerine and is poured directly into the shell. These melted explosives, after solidification, usually have a greater density than would be needed to prevent displacement on firing of the shell. Thus one of the essential conditions of proper charging is attained. It is necessary only to avoid free spaces and hollows which may form by contraction when the material solidifies, especially in the upper portions.

As before mentioned, an explosive fused into a compact homogeneous mass is generally less sensitive to shock than when in the powdered condition. That is an advantage, but care must be taken to prevent the formation of crystals during the solidification. To this end the material is stirred with a wooden ladle after solidification begins, so as to interfere with crystal formation. This operation is called "touillage" (stirring). Single compounds used alone, such as picric

acid and TNT, have a tendency to form large crystals, rendering the process quite risky. On the contrary the tendency to crystal formation is much less marked in mixtures, especially eutectic mixtures.

Xylite, or TNX, melts at 170 deg. C. and cannot be used alone for charging in the fused state. Mixing with other substances not only lowers the boiling point but brings about a particularly fine and homogeneous structure, favorable to safety. It is not always possible to use a eutectic mixture, however, for the melting point may be brought below that prevailing in munition depots.

Table II gives the proportions of some fused explosives which have been studied and pressed into service or could have been used if the need had developed.

TABLE II—PROJECTILE EXPLOSIVES CHARGED IN FUSED STATE

	Composition—Per Cent									
Picric acid	100									
Trinitroresol		40	80	60	70	55	50	80	60	
Dinitrophenol			60		40	10	10			
TNT	100					35		30	10	40
Xylite							20			
Mononitronaphthalene				30			50			
Dinitronaphthalene			20							10

Ammonium nitrate melts at 166 deg. C., at which temperature it also starts to decompose. The melting point is lowered by mixing with sodium nitrate or ammonium thiocyanate, NH_4SCN , which also aids combustion. The formula used was:

Ammonium nitrate	71 per cent
Sodium nitrate	5 per cent
Ammonium thiocyanate	11 per cent
Powdered aluminum	13 per cent

The mixture of salts is first fused alone and then the aluminum is mixed in by simple stirring. This explosive may be poured at temperatures below 130 deg. C. and is used in shells of large caliber.

CHLORATE EXPLOSIVES

The alkali chlorates and perchlorates are explosive compounds, but on account of their sensitiveness the danger of handling them is great, and this stood in the way of large-scale production for a long time. It is only within the last 20 years that the problem has been solved by incorporating the salts in a combustible material of plastic nature. This material is melted, the chlorate mixed in by processes involving a minimum amount of friction and the mixture is then cooled. The plastic material may be a solution of nitrated hydrocarbons in castor oil, or simply paraffine or vaseline, fats, or a mixture of such substances. The use of this class of explosives for war needs had a peculiar interest for France.

The preparation of chlorates and perchlorates is relatively simple. It involves none of the materials needed for other explosives; no hydrocarbons or nitrates; no concentrated nitric or sulphuric acids. The essential raw material is sodium chloride, which France produces in abundance from salt marshes and mines. Another requisite is electric energy. France is well supplied with water power, which was in great demand for numerous other war products—chlorine, calcium carbide, aluminum, ferro-alloys, chromium, manganese, special steels. It was possible, however, to divert a sufficient amount for chlorate manufacture.

Unfortunately, however, the chlorates are more sensitive to shock and friction than the other two classes

(nitro-compounds and nitrates) and for this reason could not be employed in projectiles of high initial velocity in which the charge undergoes a sudden and violent compression at the instant of departure from the gun. Hence this class of explosives was reserved for mine operations and for projectiles of low initial velocity—for instance, in hand grenades, aviation bombs and trench mortar shells.

CONCLUSION

Such were the problems that confronted the French chemists at the beginning of the war and such were the steps taken to solve them. It has been shown in a general way how much preliminary work is necessary to develop a new explosive. A long series of preliminary investigations is necessary; first of all in the laboratory, to determine the characteristic properties, heat evolved, pressure developed, sensitiveness, velocity of detonation, melting point and other empirical tests approximating the conditions in practice, such as the enlargement produced in a hollow block of lead or in the earth, or the crushing of a lead cylinder. Then the investigation must be carried over to actual use; charging shells, safety test by actual firing, proper charging density by examination of material in recovered shell, fragmentation, volume of shell holes produced, etc. The results of this work were such that the French army was able to meet all contingencies, as far as ammunition was concerned.

Acetone as a Solvent for Varnish-Gums, Resins and Shellacs

A critical examination of the solvent properties of acetone, produced by the destructive distillation of calcium acetate, is being conducted at the Mellon Institute of Industrial Research of the University of Pittsburgh, Pittsburgh, Pa., in order to ascertain its value as a commercial solvent.

In the course of the work on the solvent properties of acetone, a number of gums, shellacs and natural and artificial resins have been investigated. The percentage of acetone-soluble material in water-gums was found to be considerably less than in copal resins. The former contained from 7 to 17 per cent of acetone-soluble material, while the solubility of the latter class of gums varied from 30 to 100 per cent in the same solvent. The solubility of water-gums at room temperature was found to be quite low, while the copal resins tested were either miscible in all proportions or in a concentrated solution with a separation on dilution. The solubility of shellacs and resins varies somewhat with the grade of product. The WW grade resin is entirely soluble and miscible in all proportions, while inferior grades contain different amounts of insoluble material: the part soluble, however, is miscible in all proportions at 25 deg. C.

It was noted that the addition of another solvent, as methanol, to acetone greatly increased its solvent properties. Acetone was found to be miscible in all proportions with all the ordinary commercial solvents tested, thus permitting composite solvents to be had, the solvent power of which greatly exceeds that of the individual solvents.

The present grade of acetone obtained from calcium acetate is of excellent homogeneity and uniformity. Its low specific gravity gives it a larger volume per pound and thus lowers its price per gallon when compared with a number of ordinary commercial solvents.

Mechanical Properties Of Commercial Iron

BY ZAY JEFFRIES AND R. S. ARCHER

Definitions of Various Terms
Used in the Art of Testing
Materials, and a Discussion of
How Various Circumstances Sur-
rounding the Test Affect the
Results on Annealed Bars of
Common Structural Metals

BROADLY speaking, the mechanical properties of metals are those properties which describe the behavior of metals in the mechanical arts. The conditions to which metals are subjected, both in service and in the fabricating processes which precede service, are of unending variety, so the engineer is confronted with the problem of determining the suitability of metals for the various conditions of fabrication and of service. It is to meet this problem that the science of mechanical testing has been developed.

The most certain evidence of the behavior of a metal under a given set of working conditions consists in the accumulated results of many trials under those conditions. Actual working conditions are often very complex, however, and the accumulation of such evidence is a long, slow and costly process. It is, therefore, desirable to analyze the complex conditions into a relatively small number of more simple elements. The common tests of metals, such as the tensile test, are designed to determine these more elementary properties.

COMPLEXITY OF "SIMPLE" PROPERTIES

A mechanical test is merely a mechanical operation in which the variables are controlled and the results quantitatively measured. The smaller the number of independent variables the more easily are they controlled and hence the greater the accuracy of the test and the more fundamental the nature of the property disclosed. Considering our "simple" mechanical properties of metals in this light, we find that they are quite complex in comparison with the properties regarded as fundamental physical constants. The melting point, for example, of a metallic element is sufficiently fixed for practical purposes to be regarded as absolute. Pressure and grain size exert a slight but negligible influence. The tensile strength, on the other hand, cannot be stated with satisfactory accuracy even for a pure metal without defining the temperature, structure of the metal, form and size of test piece, and rate of loading.

There is, therefore, a need for still further simplification in testing—that is, for further analysis of the common mechanical properties and the defining of properties of a more fundamental nature. Such an analysis must be made with the assistance of all the knowledge afforded by metallography of the structure of metals, and the effects of deformation and temperature on structure. Attempts have been made and are unfortunately still being made to solve these problems by pure mathematics.

The analytical method is of course limited. Even if it were possible to define all of the fundamental constants upon which the mechanical properties of metals depend, and to determine them, the synthesis of these elements into results of direct utility would undoubtedly present such difficulties that in many cases the empirical method of attack would be more easy and more certain. Such a knowledge of fundamentals would

be invaluable, however, in classifying empirical information and in pointing the way to new knowledge.

It is almost needless to say that a fundamental study of the properties of metals and alloys should begin with the pure metals. There has nevertheless been some tendency to give the properties of the pure metals less attention than they deserve, perhaps because of failure to recognize their true complexity. While it is true that metals are most widely used in alloyed form, it is also true that a fundamental understanding of the properties of the alloys requires an understanding of the properties of the pure metals upon which they are based.

CLASSIFICATION OF PROPERTIES

All of the mechanical tests consist in observing quantitatively the behavior of metals under stress, the various tests being differentiated by the type of specimen and the manner and rate of application of stress. According to the rate of application of load, tests are often divided into two classes, called "static" and "dynamic." The so-called static tests include the ordinary tension, compression, torsion and transverse tests, as well as the Brinell hardness test. The Shore scleroscope test for hardness would also probably be classified as a static test. The dynamic tests include the various types of alternating stress or fatigue tests and the single and repeated blow impact tests. (Another division is sometimes made into static tests, repeated stress tests and impact tests.)

The effects of stress are deformation and rupture. The mechanical properties of metals may be classified in a general way in three groups, describing (1) *resistance* to deformation and rupture; (2) *capacity* for deformation without rupture; and (3) *work* of deformation or rupture.

In the first group, which may be designated by the general term *hardness*, are included the elastic limits, elastic moduli, tensile strength, transverse strength, shearing strength, endurance limit under repeated stresses, Brinell hardness, scleroscope hardness, etc.

The second group may be covered by the term *plasticity*, and includes the elongation and reduction of area in the tensile test, the relative compression without rupture in the compression test, the angle of twist in the torsion test, the deflection at failure in the transverse test, angle of bend in the bend test, as well as the general properties denoted by the terms ductility and malleability.

The work of deformation and rupture is the product of the resistance to deformation by the amount of deformation, and can be calculated from the complete data of any test in which both load and deformation are observed continuously or at close intervals. It is represented by the area under the stress-strain curve. The only common test in which the work is measured directly is the single-blow impact test.

In a test specimen subjected to simple stress, as ten-

sion or compression, the energy of deformation is applied uniformly to all of the metal under test, as long as the deformation is elastic. The energy is stored as elastic energy, recoverable on removal of the load, and is called *resilience*. The work expended in deforming unit volume of a material to its elastic limit is the modulus of resilience.

When the elastic limit is exceeded, plastic deformation may take place in a fairly uniform manner, as when a tensile specimen draws out evenly without necking. The work of permanent deformation may then be calculated per unit volume of the metal. When the deformation ceases to be uniform, as when necking occurs, it is no longer possible to refer the energy to a definite volume of metal. Supposing the stress-strain diagrams of two tensile test-bars to show the same total work of rupture, the maximum energy absorbed per unit volume of metal will be in the bar having the greater reduction of area.

CAUSE OF HARDNESS AND STRENGTH

Metals owe their resistance to deformation to the forces between the atoms. These forces are both attractive and repulsive, and are directional. The repulsive forces are manifested by the resistance of metals to hydrostatic pressure by which the atoms are forced closer together in all directions. Under ordinary compression loading, the atoms are forced together in the direction of the compression but apart in the direction of the secondary tensile stresses. Under direct tension the distances between atoms are increased in the direction of the load and decreased in the direction—at right angles—of the secondary compressive stresses. There is no condition of loading corresponding to a negative hydrostatic pressure, under which the interatomic distances would be increased in all directions.

Any permanent deformation of a metal involves changes in the relative positions of some of the atoms, and, therefore, the breaking, temporarily at least, of some interatomic "bonds." The rupture of any material, whether with or without permanent deformation, also involves the breaking of interatomic bonds. The greatest possible resistance that a material can offer to deformation or rupture is the summation of all the interatomic bonds on a plane through the specimen normal to the stress, a summation which may for convenience be termed the "absolute cohesion" of the material. Actually such a summation of forces is never realized, because rupture always takes place by degrees, and the breaking of atomic bonds is not simultaneous. The tensile strength of a material merely represents the maximum number of atomic bonds that come into play simultaneously during the test.

Absolute cohesions of metals are far in excess of the values obtained for tensile strength. A qualitative illustration of this fact may be found in a consideration of some properties of pure iron. The tensile strength, after hot-rolling, is about 40,000 lb. per sq.in., a value representing as usual the maximum load divided by original cross-section. If the actual reduced area of the test-piece is measured throughout the progress of the test and the stress computed on this basis, a value will be found for the maximum stress which is much higher than the tensile strength. The maximum stress will then be about 80,000 lb. per sq.in. Severely cold-worked iron may show a tensile strength of 150,000 lb. per sq.in. The maximum actual stress is again somewhat higher (165,000), but not in so large a ratio as in the

case of the hot-rolled iron. Even in the cold-worked iron, rupture still takes place by degrees—that is, by a kind of tearing action—so that the highest of these figures still does not represent the inherent absolute cohesion.

Some very interesting tests of glass have been reported by Griffith¹. In ordinary fibers of 0.040 in. diameter the material had a tensile strength of about 25,000 lb. per sq.in. The tensile strength was found to increase as the diameter of the fibers decreased, and in very fine fibers, carefully prepared, surprisingly high values were obtained. The maximum strength recorded was 498,000 lb. per sq.in. at a diameter of 0.00016 in. Plotting the reciprocal of the tensile strength against the diameter of the fiber and extrapolating to zero diameter, Griffith found a value of 1,600,000 lb. per sq.in., representing the theoretical "absolute cohesion" of the glass.

Calculations based on the energy required to separate the atoms of metals by vaporization give values up to about 5,000,000 lb. per sq.in. for the "intrinsic pressure," a quantity which is theoretically of the same order of magnitude as the absolute cohesion.

The accuracy of Griffith's extrapolation and of values for cohesion derived from the heat of vaporization may be questioned. The actual numerical values reached are of little significance. The important thing is that metals possess very great inherent cohesion, greater probably than is ever realized in tensile tests of the pure metals or their strongest alloys. Looked at from this point of view, the problem of the hardening and strengthening of metals by various means becomes more simple. Instead of inquiring why metals are so strong, we may better ask why metals are so weak.

NATURE OF PLASTICITY

Permanent deformation of any material involves displacements within the material, during which the cohesion is overcome between the parts undergoing relative displacement. The property of plasticity depends upon the ability of such displaced parts to re-establish cohesion in their new positions. This ability is a conspicuous characteristic of liquids, and the plasticity of many materials depends on the possession of a structure like that of liquids, or on the presence of some liquid, to preserve continuity during deformation. Glass is a typical example of undercooled liquid which at certain temperatures is distinctly plastic. Even after cooling to temperatures of great rigidity its structure is still that of a liquid, in the random arrangement of molecules. Clay, on the other hand, owes its plasticity to the presence of a continuous matrix of water which holds together the fine particles of non-plastic solid matter.

According to the amorphous metal hypothesis of Beilby, metals preserve their continuity during plastic deformation by the generation of fluid amorphous films on the surfaces of slip. On this basis the plasticity of crystalline materials depends on their ability to generate such amorphous films. It is quite conceivable, however, that crystalline fragments might adhere to each other without the intervention of a layer of undercooled liquid or vitreous amorphous material.

Complexity of structure is opposed to plasticity. The molecules of a liquid establish cohesion bonds with each other easily without the necessity of any particular arrangement. Hence two bodies of a given liquid unite with each other on contact. When contact is brought about between two solids whose rigidity depends upon a highly organized structure, the establishment of cohesion is not so easy. When a piece of wood, for example, is broken in two, it is practically impossible to replace the parts either in their original positions or in any other positions in which cohesion is re-

¹"The Phenomena of Rupture and Flow in Solids," A. A. Griffith, *Phil. Trans.*, Series A, vol. 221, pp. 163-198.

established. In metals the structure, though crystalline, is relatively very simple. It is easily imagined that the fragments of a metallic crystal broken along a crystallographic plane might be brought into contact on this plane in perfect registry so that the original space lattice, and hence cohesion, might be re-established. Probably plastic deformation of metals involves both this type of junction and junction by more or less disorganized or amorphous metal. The monatomic condition of aggregation of the metals and their simplicity of crystalline structure favor both mechanisms.

COMMON PROPERTIES OF COMMERCIAL IRON

In Table I are given the common mechanical properties of a very pure grade of iron, in the annealed condition after working. The tests were all made at ordinary temperatures and under usual conditions. Besides giving useful information about this most important metal, these figures will serve to illustrate a brief discussion of some of the mechanical properties.

The elastic and proportional limits are practically identical. Difference in the values given reflects chiefly the difficulty of an accurate determination: the actual results obtained depend on the sensitivity of the measurements of extension. When metals are tested at temperatures well below that of recrystallization, the passing of the elastic limit represents the beginning of plastic deformation by transcrystalline slip. At temperatures near or above the recrystallization temperature, intergranular flow may take place and mark the elastic limit; the stress required varies greatly with the time of application.

The yield point is well marked in iron and mild steel, representing a considerable extension at nearly constant stress. During this stage the formation of slip-bands is general throughout the specimen; the effect is visible on the machined surface of a test-bar, which becomes dull. In non-ferrous metals the yield point is not nearly so well marked and can be defined only as the stress at which some arbitrarily selected extension occurs.

Up to the elastic limit the metal is unaffected by the application of the test load. Beyond this point, however, the deformation incident to the test alters

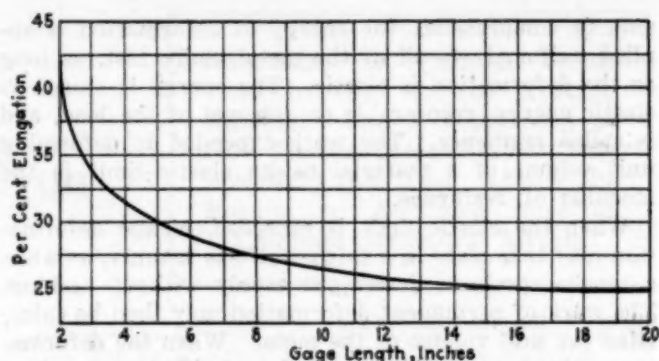


FIG. 1—EFFECT OF GAGE LENGTH ON ELONGATION OF SOFT STEEL
Test piece 0.688 in. diameter

the structure and properties of the metal. Elongation, reduction of area and tensile strength therefore depend not only on the original condition of the metal but also upon the effect of the testing operation itself. The mechanism and effects of plastic deformation must be considered in interpreting the results of tests in which the metal is plastically deformed.

GENERAL AND LOCALIZED ELONGATION

Most of the ductile metals draw down at the point of fracture so that the relative elongation at this point is greater than the general relative elongation along the bar. Total elongation as measured is, therefore, made up of two parts, one a general elongation approximately uniform along the bar and the other a variable local stretch where the bar necks down. The maximum local stretch can be calculated from the reduction of area on the assumption that the volume of the metal remains constant (which is practically true). When the reduction of area is high the per cent elongation on the constricted portion of the bar may be several times the per cent general elongation. Hence on bars of the same cross-section, the per cent elongation, measured so as to include the fracture, is greater the shorter the gage length. (See Fig. 1.) If the gage length remains constant but the test-bars differ in cross-section, then the per cent elongation is greater on the larger bar, as illustrated by the values given in Table I. The gage length is 2 in. in each case. On the $\frac{1}{4}$ -in. test-bar the per cent elongation was 48.3, made up largely of the local stretch at the fracture. Wire of 0.025 in. diameter showed elongation of 23.7 per cent, representing almost solely the general elongation—since the contribution of the small local stretch is in this case negligible.

Reduction of area in tension is characteristic both of the metal and the conditions of test. General elongation is to a similar extent characteristic of the metal; elongation as commonly measured, however, includes a factor which is proportional to reduction of area. Reduction of area and general elongation are not affected in the same way by changes in temperature and other variables. Since the measured elongation includes both factors, it will be found that the effect of temperature and other conditions depends largely on the ratio of gage length to cross-section. The relative elongation found by the tensile test is the most common criterion of ductility, the general elongation being probably a better indication than the total elongation measured over a short gage length.

DUCTILITY AND MALLEABILITY

Ductility is capacity for being drawn out, or plastically deformed, by direct tensile load without rupture.

TABLE I—PROPERTIES OF ANNEALED ARMCO IRON

Property	Value	Remarks
Elastic limit in tension, lb. per sq. in.	14,400	
Proportional limit in tension, lb. per sq. in.	16,100	
Yield tension, lb. per sq. in.	19,000	
Ultimate tensile, lb. per sq. in.	42,400	$\frac{1}{4}$ in. diameter specimen
Ultimate tensile*, lb. per sq. in.	48,200	0.025 in. diameter specimen
Per cent elongation in 2 in.	48.3	$\frac{1}{4}$ in. diameter specimen
Per cent elongation in 2 in.*	23.7	0.025 in. diameter specimen
Per cent reduction in area	76.2	$\frac{1}{4}$ in. diameter specimen
Per cent reduction in area*	76.0	0.025 in. diameter specimen
Elastic limit in compression, lb. per sq. in.	19,400	
Proportional limit in compression, lb. per sq. in.	19,200	
Yield point in compression, lb. per sq. in.	20,600	
Ultimate in compression, lb. per sq. in.	31,200	
Elastic limit in torsion, lb. per sq. in.	12,400	
Proportional limit in torsion, lb. per sq. in.	12,500	
Yield point in torsion, lb. per sq. in.	13,600	
Modulus of elasticity in torsion, lb. per sq. in.	11,770,000	
Young's modulus in tension and compression*, lb. per sq. in.	30,000,000	
Endurance limit, Farmer rotating beam, lb. per sq. in.	26,000	
Endurance limit, Olsen-Foster reversed torsion, lb. per sq. in.	12,500	
Brinell hardness number*	75	
Shore scleroscope hardness	18	
Energy of rupture on impact, ft.-lb.	19.3	Specimen 0.394 in. square, notched to $\frac{1}{4}$ depth, bottom of notch 0.04 in. radius.

* With the exception of the properties marked with asterisk, the results given in this table were reported by H. F. Moore, Eng. Exp. Sta., Univ. of Ill.

It is a property which requires both plasticity and tensile strength, and does not, therefore, necessarily reach a maximum value when plasticity is at a maximum—most metals have the greatest plasticity above the recrystallization temperature, but greatest ductility below the recrystallization temperature; they have not sufficient tensile strength above the recrystallization temperature to sustain the loads necessary to draw them out. Malleability is capacity for plastic deformation without rupture by hammering. It does not require as much resistance to tension as does ductility, since the metal is not subjected to the entire deforming load in direct tension. Secondary tensile stresses are developed, however, of greater or less magnitude depending on such factors as the manner of hammering and shape of dies. Some strength is therefore required, in the absence of which the metal is said to be "tender." The process of drawing out by swaging in confined dies is less exacting on the strength of the metal than are most forms of hammering, and can often be carried out when successful working by hammering is not possible.

There are no fixed standards of plasticity, ductility and malleability. In fact, these properties are so loosely defined that they cannot be expressed accurately even in relative terms. While the term plasticity refers chiefly to *capacity* for deformation, it also carries some implication of *ease* of deformation. Consider iron, for example, at the temperatures 1,000 and 1,100 deg. C. At either temperature it can be plastically deformed to an almost unlimited extent. It is softer at the higher temperature, however, and would commonly be considered more plastic. Since it can be deformed more easily by hammering or rolling at the higher temperature, it would also be generally considered more malleable. Ductility refers more definitely to capacity for deformation by drawing, but there are various ways of estimating such capacity. Some of the older tables in which the metals are arranged in the order of ductility are based on the fineness of the wire which can, or rather has, been drawn, just as the tables of malleability are based largely on the thinness of the sheet or foil that can be beaten. Another criterion is the total reduction in section, or extension in length, possible by drawing without intermediate annealing; on this basis copper is much more ductile than iron at room temperatures. Relative ductility is also sometimes measured by the maximum reduction possible in the first die or the first few dies. In this respect iron is more ductile than copper.

It will be noted in Table I that the tensile strength of the iron wire is about 14 per cent higher than that of the $\frac{1}{4}$ -in. test-bar. Presumably the two materials are similar as to structure, and the difference in strength is in accordance with the general observation that tensile strength increases as the diameter of the material decreases. This has been recognized in standard specifications for wire.

It is remarkable that this material showed an endurance limit under repeated stress about 60 per cent higher than its elastic limit in tension. Although there is no general law connecting endurance limit with the static properties, the endurance limit is usually less than the elastic limit in tension. It may be remarked in passing that the endurance stress of 26,000 lb. per sq.in. given in the table was calculated from the formula for a transversely loaded beam, which depends upon the assumption of perfect elasticity, yet the

calculated stress is well above the known initial elastic limit of the metal.

RATE OF LOADING

Time plays an important part in the behavior of metals under stress. Thurston¹ divided metals and alloys into two classes according to whether or not they exhibited flow under prolonged application of stress. At ordinary temperatures, iron will sustain indefinitely any load which it will sustain for a short time. Many of the non-ferrous metals, however, especially the softer metals, like lead, tin and zinc, yield gradually under constant load; in the course of years, lead roofing will creep under its own weight.

Variations in the rate of applying load in the ordinary tensile test have a marked effect on both tensile strength and elongation of soft metals, which are as a rule increased by increasing the rate of loading. Ordinary variations in the rate of testing have practically no effect on the tensile properties of iron and steel. Under extremely rapid loading the elongation may be increased. Some tests have been reported by Maitland² on a steel which had a tensile strength of 58,000 lb. per sq.in. with an elongation of 27 per cent in 2 in. when broken in the usual manner. A specimen was screwed in blocks arranged so as to fall vertically in a slide for a certain distance, when the top block was arrested by stops and the specimen was broken by the momentum of the lower block. Broken in this manner the elongation was 47 per cent. The rate of loading was still further increased by driving the ends of the test-bar apart by exploding gunpowder or guncotton. Under these circumstances the elongation was up to 62 per cent. Such increases by rapid loading are not always obtained.

Instead of causing failure at a low stress, extremely slow loading of iron causes a considerable increase in tensile strength. Wires broken after a gradual application of load during about 2 months gave a tensile strength about 25 per cent higher than that obtained in a quick test. This behavior, which is peculiar to iron in its magnitude, will be discussed later and correlated with other properties.

Time plays an unimportant role in causing fatigue, especially in iron and steel. Thus the metal can be subjected without failure to a static load much greater than its endurance limit under repeated stresses for a period of time greater than that required in the fatigue test. It is the reversal of deformation rather than the prolonged application of load that does the damage.

There has long been a rather general belief that metals, particularly iron and steel, break more easily under suddenly applied load—i.e., shock or impact—than under slowly applied load. Impact tests have been made on rails and axles as a matter of routine inspection, to determine their susceptibility to easy fracture by shock. Several types of impact testing machine have been developed; the most common one breaks a notched bar by a single blow and measures the energy of rupture. It has been shown that for many kinds of steel the energy absorbed is practically the same whether the bar is broken in the impact machine or by slow bending. In other words, the test is merely a bend test of a notched bar. Some steels, however, appear to break much more easily by rapid than by slow bending.

¹Thurston's "Materials of Engineering, Part 3, Alloys, Brasses and Bronzes," p. 489. John Wiley & Sons, Inc.

²"The Treatment of Gun Steel," *Proc. Inst. Civil Engrs.*, vol. 89, p. 120.

Legal Notes

BY WELLINGTON GUSTIN

Leasing of Equipment to Dealers Not Unfair Competition—Court Discusses Competition

In the case of the Sinclair Refining Co. against the Federal Trade Commission, the Circuit Court of Appeals set aside the order made by the commission against the Refining company and an appeal by certiorari was made to the United States Supreme Court. (42 Sup. Ct., 183.)

COMPLAINT BY FEDERAL TRADE COMMISSION

The substance of the complaint against the Refining company was that it leased for a nominal consideration its oil pumps, storage tanks and containers and their equipment to persons who purchased oil from it with the understanding that same should not be used by the lessees to hold or pump the oil of any competitor. It was also charged that the leases were made on consideration that lessees should not purchase or deal in the products of a competitor.

The question presented was whether, under the terms of the contract between the Refining company and its customer, the leasing of containers and pumps is an "unfair method of competition" as these words are used in section 5 of the Federal Trade Commission act of Sept. 26, 1914, or whether the effect of such leasing be substantially to lessen competition and tend to create for the company a monopoly in the business of selling its products in violation of section 3 of the Clayton act.

The Court of Appeals says that neither of these sections gives the Federal Trade Commission power to regulate trade generally. And jurisdiction under section 5 exists only where there are practices that amount to a fraud in regard to some public or private right, otherwise they do not amount to an unfair method of competition. This court was of the further opinion that the company had the undoubted right to furnish any and every purchaser of its products such containers and conveniences to aid him in delivering such products into the possession of the consumer as it might see fit, and at such charges as it might see fit. The right to fix prices is not given to the Federal Trade Commission, it says, and the only cases where the question of prices has come into consideration have been those wherein the making of a price—in some cases high, in others low—has been used as an element in some fraudulent scheme of oppression. The price which one may put upon that which he has to sell or lease is a matter wholly his own.

LEGITIMATE WEAPONS OF COMPETITION

Turning its discussion to competition, the court says this is not an unmixed good. "It is a battle for something that only one can get; one competitor must necessarily lose. The weapons in competition are various. Superior energy, more extensive advertising, better articles, better terms as to time of delivery, place of delivery, time of credit, interest or no interest, freights, methods of packing, lower prices, more attractive and more convenient packages, superior service and many others are and always have been considered proper

weapons. Expense attending the use of any weapon, the foolishness of it, the fact that a method is uneconomical or that the competitor cannot meet any method or scheme of competition because it will be ruinous to him to do so have not, nor has either of them, ever been held unfair. Such things are a part of the strife inherent in competition."

The fact that the company loaned an expensive pump and container, more than its competitors did for the customer, does not make the transaction unfair, says the court further. If it does, then the law must mean that the Trade Commission is set as a watch on competitors, with the duty and the power to judge what is too fast a pace for some and to compel others to slow up; in other words, to destroy all competition except that which is easy.

RIGHT OF CUSTOMERS TO HANDLE COMPETITORS' PRODUCTS NOT LIMITED

Further, this court was of opinion the company had not violated section 3 of the Clayton act. The complaint under this section against monopolizing the business is that the company made leases for the container and pump and fixed the price therefor "on the condition, understanding and agreement that the lessees thereof shall not purchase or deal in the products of a competitor or competitors of the company." But the contract showed a limitation only that the equipment should be used for the sole purpose of storing and hauling the lessor's products. There was no further agreement attempting to limit the right of customers to handle the products of competitors. Still the finding of the commission indicated the real trouble which it desired to reach to be that of leasing out costly equipment at a nominal rental far below the cost of purchasing and leasing, the effect of leasing in this manner, which smaller competitors could not meet, and by contract restricting the use of the equipment to the company's products tending to lessen competition.

TRADE COMMISSION NOT EMPOWERED TO FIX RENTALS

The necessary conclusion from the findings and order of the Trade Commission is, as put by the court: "First, that the commission deemed it lawful and proper for it to condemn certain rentals and also to fix and regulate the rentals on the equipment because the furnishing of such equipment required a large capital investment and because many competitors were financially unable to do that sort of thing." But the court points out that Congress did not bestow upon the commission such power.

Now section 3 does make it unlawful to make sales or leases on the condition, agreement or understanding that the lessee or purchaser thereof shall not use or deal in goods, etc., of a competitor where the effect of such lease, condition, agreement or understanding may be substantially to lessen competition, etc. But the company's contract with its customer does not prevent him from also dealing in products of its competitors; only its leased equipment shall be used exclusively in handling its own products. The court was of opinion that section 3 could not be construed as preventing the company, under the facts of this case, from putting such a limitation upon the use of the thing leased.

If anything further need be considered, the court points out that the effect of the orders of the Federal Trade Commission in this case would seem to be to terminate and destroy the contractual rights of persons (the customers) not parties to the proceeding.

The Oxidation of Ammonia— The Work of the Sheffield Experiment Station

BY HARRY A. CURTIS

A Study of the Fundamental Conditions Involved in the Catalytic Oxidation of Ammonia and a Résumé of the Important Unsolved Problems

DURING the war the Nitrate Division of Ordnance maintained a number of experiment stations at which research on various phases of the fixed nitrogen problem was conducted. While the building of the nitrate plants absorbed the attention of most of the Nitrate Division staff, the experiment stations accumulated a considerable amount of experimental data, and but little of this has been published.

The Sheffield Experiment Station, Sheffield, Ala., of which the writer was director, was given over, for the most part, to work on the catalytic oxidation of ammonia and the production of nitric acid from the resulting oxides. During the early part of 1918 an experimental ammonia oxidation plant, having a capacity of about 500 lb. of nitric acid per day, was constructed at this station. This small plant was put in operation in May, 1918, and was run on a 24-hour basis until January, 1919. During these several months of experimenting a great deal of data was obtained. While it is not profitable to publish much of this, the results obtained in certain cases are of sufficient interest to merit permanent record.

Since, with but few exceptions, names of the men connected with the Sheffield Experiment Station are not mentioned, the writer would have it understood that the results recorded here were obtained with the hearty co-operation of all the men assigned to this work.

THE EXPERIMENTAL PLANT

The experimental ammonia oxidation plant included the following:

(a) A 10,000-gal. storage tank for aqua ammonia. This was set alongside a railroad spur and served from a tank car. The aqua ammonia was drawn from this tank as needed into a small blow-tank and forced by air pressure to a constant head tank at the top of the ammonia still.

(b) An ammonia stripping still for obtaining an air-ammonia mixture of any desired ammonia concentration. This was built of standard cast-iron flanged pipe, 12 in. diameter by 18 ft. high. Aqua ammonia was fed in at the top through a flow meter, and air from a blower was passed up through the column, the pipe being packed with coke. A little steam was blown in at the bottom to insure complete removal of the ammonia.

(c) A catalyst chamber about 20 in. high and 1 sq. ft. cross-section. This was built of cast iron and lined with enameled terra cotta blocks. The air-ammonia mixture entered at the top through aluminum piping, and a platinum gauze was stretched across the bottom. The platinum gauze was clamped in a nickel frame and could be removed fairly readily. This catalyst chamber or "oxidizer" was designed by Captain Perley of the Nitrate Division. It gave good service, but was rather

big and heavy for its capacity. One interesting item was that this oxidizer never "howled" during operation, as many other types of oxidizers did. The oxidizer was originally designed without electrical connections, but these were later added to the apparatus and means provided for supplying electrical current up to 350 amperes.

(d) Coolers. The hot nitrous gases from the oxidizer were first cooled in cast-iron pipe and finally in Duriron, entering the absorbing towers at practically room temperature.

(e) Six stoneware towers 30 in. in diameter by 18 ft. high for absorbing the nitrogen oxides. The acid circulating system included six air-lifts made of aluminum piping and Duriron fittings.

(f) A chemical laboratory, office and library.

LOSS OF FIXED NITROGEN AT THE GAUZE

The catalytic oxidation of ammonia on anything approaching a commercial scale was a comparatively new art in the United States when we entered the war. Two or three experimental plants had been in operation for a short time.¹ Judging from the results obtained at these small plants, it was apparent that in commercial plants, under favorable operating conditions, an oxidation efficiency in the neighborhood of 90 per cent might be expected. It was explained to the writer at that time that the remaining 10 per cent of fixed nitrogen passed through the gauze as unoxidized ammonia, and that this ammonia would eventually form ammonium nitrate, and would, therefore, be recovered in a plant where the final product was ammonium nitrate. It is now known that but little ammonium nitrate or nitrate is formed beyond the gauze, even when the oxidation efficiency is low. Further, it has been found that even if ammonium nitrate were so formed it would be decomposed in the absorption towers. These facts make several United States and foreign patents valueless.

In Table I the oxidation efficiencies obtained with several different rates of air flow are compared with the amounts of ammonium salts formed beyond the gauze. The gauze used was 12x12 in., woven 80 mesh per inch, with wire 0.003 in. diameter.

¹Semet-Solvay Co. at Syracuse, N. Y.; American Cyanamid Co. at Warners, N. J.; General Chemical Co., at Laurel Hill, L. I.

TABLE I—OXIDATION EFFICIENCIES AND AMOUNTS OF AMMONIUM SALTS FORMED

Date	Duration of Test, Hours	Number of Samples Analysed	Rate of Air Flow to Gauze Cu.Ft. Per Min.	Average Per Cent NH ₃ in Gas to Gauze	Av. Oxidation Efficiency, Per Cent	Av. Fraction of the NH ₃ Converted to Ammonium Salts
7/9/18	8	10	15	11.45	93.1	0.016
7/10/18	51	5	20	9.35	86.4	0.019
7/11/18	101	9	25	11.0	86.0	0.021
7/12/18	101	10	30	10.75	83.2	0.028
7/17/18	14	11	40	11.2	81.7	0.026
7/18/18	81	8	50	10.6	76.1	0.035
7/19/18	121	12	60	10.3	71.4	0.044

If the average values for the ammonia oxidation efficiencies and for the percentages of ammonia converted to ammonium salts be plotted against the rates of air flow, the graphs of Fig. 1 are obtained. It will be seen that even when only 71.4 per cent of the ammonia was oxidized to nitric oxide at the gauze, but 4.4 per cent appears below the gauze as ammonium salts.

EFFECT OF SMALL PERCENTAGES OF IRIIDIUM IN THE PLATINUM GAUZE

It was thought at one time that the platinum used in making up a platinum gauze catalyst had to be free from iridium. This was rather an important point because of the fact that it is difficult to draw fine wire of pure platinum, whereas the addition of a little iridium, even a fraction of a per cent, gives a metal much more easily handled and from which a finer wire can be drawn if desired.

A study of the oxidation efficiency of a gauze woven from an alloy of 99 per cent platinum and 1 per cent iridium at the Sheffield Experiment Station showed that the iridium had no measurable effect. The alloy for this gauze was made by the U. S. Assay Office of New York and the gauze by the Newark Wire Cloth Co. The wire was 0.0026 diameter and the mesh 80 per inch.

In Table II the average results for various rates of gas flow for a pure platinum gauze are compared with those obtained under parallel conditions with the platinum-iridium gauze, and the data are plotted in Fig. 2.

ELECTRICAL HEATING OF PLATINUM GAUZE

During the construction of the nitrate plants there was considerable discussion as to whether it were possible to avoid electrical heating of the platinum gauze catalyst. The oxidation of ammonia is an exothermic reaction, and it may be calculated that the heat of the reaction, when 10 per cent of ammonia is present in the

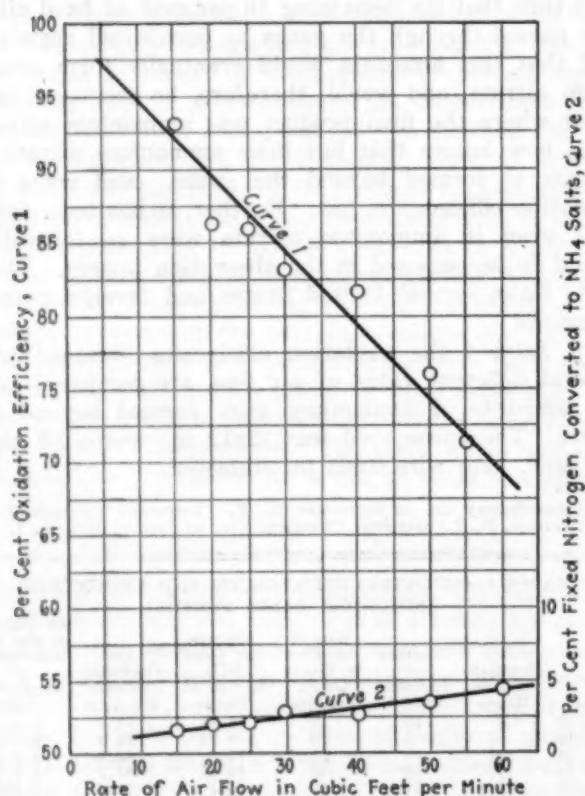


FIG. 1—AMMONIUM SALTS FORMED BELOW THE GAUZE AT VARIOUS OXIDATION EFFICIENCIES

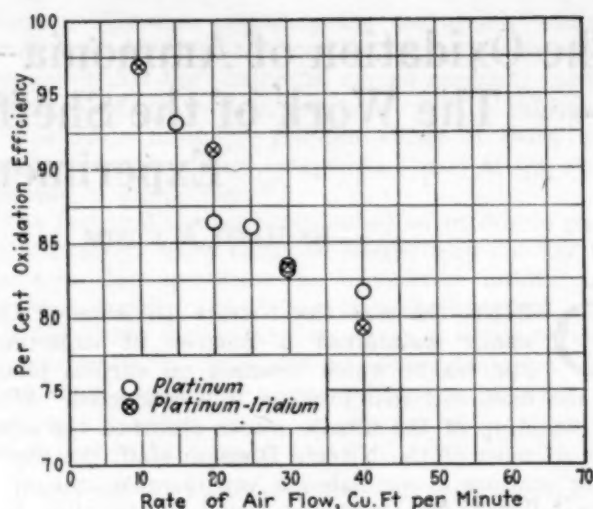


FIG. 2—OXIDATION WITH PLATINUM AND PLATINUM-IRIDIUM ALLOYS

Rate of Air Flow, Cu. Ft./Min.	Average Oxidation Efficiency Platinum	Platinum-Iridium
10	97.5	96.9
15	93.5	93.5
20	91.5	91.5
25	86.5	86.5
30	83.5	83.5
40	81.5	79.3

air-ammonia mix, is sufficient to raise the temperature of the gaseous products of reaction to about 800 deg. C. It was thought at one time that the optimum gauze temperature was in the neighborhood of 600 deg. C., and it was argued that but little if any additional heat was required in the gauze.

In order to study the effect of changing the temperature of the gauze when the various percentages of ammonia were being used, the following procedure was adopted: The experimental plant was operated under given conditions until it became stabilized. Samples above and below the gauze were then taken and immediately after this the electric current to the gauze was cut down so as to give a marked lowering of the gauze temperature. After a few minutes, samples were again taken. Since the plant was operating steadily, the analytical results obtained from the samples represent only the temperature effect at the gauze. This procedure was repeated for several different concentrations of ammonia. The results are given in Table III and expressed graphically in Fig. 3. They show beyond question that the gauze was in every case operating below its optimum temperature, even with the high electric current consumption (about 3.3 kva.).

The temperatures which are recorded in Table III were taken with an optical pyrometer and are approximately 100 deg. lower than the actual temperatures which obtained.

When using a single flat gauze in any such apparatus as the one employed, there is little preheating of the gas mixture and the addition of heat to the gauze by electrical means is advantageous. It must also be remembered that the electric current has a very valuable stabilizing effect, for the electrical conductivity of platinum increases as the temperature is lowered, and if, for any reason, the heat supplied by the reaction itself falls off, the electric current automatically increases and keeps the gauze hot until normal conditions are again established.

TABLE III—EFFECT OF TEMPERATURE CHANGE IN A SINGLE FLAT GAUZE CATALYST

Time Between Sampling, Min.	Per Cent NH ₃ by Volume, Per Cent	Temperature of Gauze, Deg. C.	Oxidation Efficiency, Per Cent
3	8.8	693 too low to read	90.3 87.2
5	10.1	715 673	90.1 87.4
5	11.3	765 687	90.9 87.1
5	12.2	781 733	90.6 87.0
5	12.2	781 733	90.6 86.0
5	13.4	816 760	86.1 80.9
5	13.8	831 775	73.9 70.7
2	15.6	914 876	56.7 51.8

Since, however, the reaction involved is highly exothermic, it appears that a system of heat interchangers might well be employed to heat the gas mixture ahead of the gauze and so eliminate the electric heating. In 1917 the Bureau of Mines, in co-operation with the Semet-Solvay Co., designed and constructed a cylindrical gauze oxidizer³ in which a slight degree of preheating is secured. This cylindrical gauze oxidizer was modified by Captain Perley of the Nitrate Division and installed at U. S. Nitrate Plant No. 1. Using byproduct coke-oven ammonia, the modified apparatus did not give a satisfactory efficiency. It also failed in trial runs with ammonia from cyanamide. Later, however, by installation of a heat interchanger for the air ahead of the gauze, the oxidizers at Plant No. 1 gave good results⁴ on short runs. It is unfortunate that these experiments could not be continued and the new apparatus tried on cyanamide ammonia.

AMMONIA OXIDATION WITH DOUBLE GAUZE

It had been shown that the oxidation efficiency of a single flat gauze is increased by use of electrical heat in the gauze. It was also known that where no electrical heat is added, a double layer flat gauze gives a little higher efficiency per unit weight of gauze. This increase in efficiency may result both from the somewhat higher temperature at which the double layer gauze operates and to the reduction in effective gauze mesh. The idea naturally occurs to use two gauzes electrically insulated from each other, applying electrical heat only to the up-stream gauze. This idea was put into effect at the Sheffield Experiment Station in December, 1918. It was later learned that the same scheme was tried in England.

The results obtained at Sheffield were excellent, as will be seen in the data tabulated in Table IV. The two gauzes were clamped in the same nickel holder, but electrically insulated from each other by asbestos board around the edges and by some very pure asbestos fiber packed loosely between the gauzes where exposed to the gas stream. The gauzes were separated by a distance varying between $\frac{3}{8}$ in. and $\frac{1}{2}$ in. In the particular

³See U. S. Pat. 1,321,376.

⁴G. A. Perley, *Chem. & Met. Eng.*, vol. 22, p. 125 (1920).

TABLE IV.

Date	Duration of Test Period, Hr. Min.	No. of Samples	Cu. Ft. Air Per Minute	Average Per Cent NH ₃ by Volume	Average Oxidation Efficiency, Per Cent
12/12/18	10 20	11	20	8.5	93.7
12/13/18	3 40	6	40	10.4	95.4
12/13/18	17 52	8	60	9.3	92.4
12/14/18	2 40	4	78	9.9	89.0

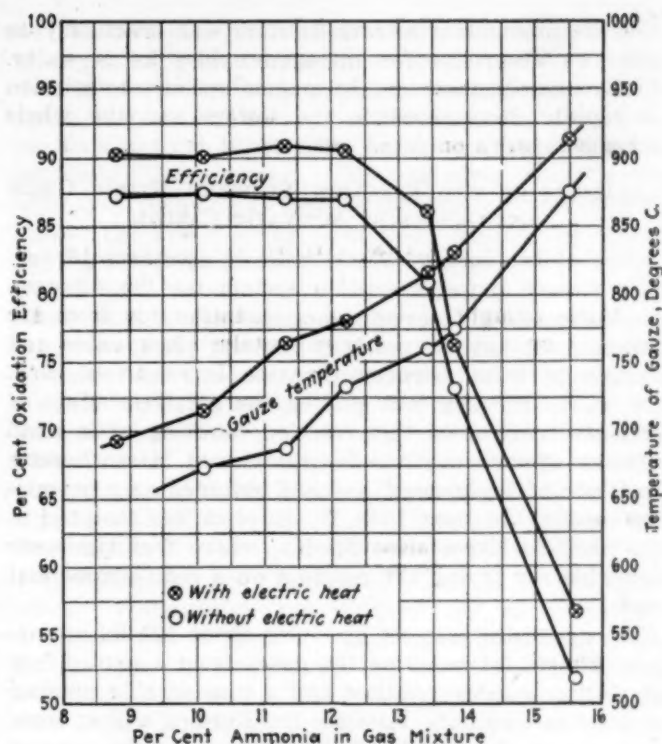


FIG. 3.—EFFECT OF GAUZE TEMPERATURE ON OXIDATION EFFICIENCY FOR VARIOUS PERCENTAGES OF AMMONIA

experiment referring to the data given in Table IV, the upper gauze was of pure platinum and the lower one of an alloy of 90 per cent platinum and 10 per cent palladium, but the use of the alloy had no bearing on the experiment. Both gauzes had been activated in earlier runs.

It was then decided to try the same arrangement of gauzes, but with a base metal gauze replacing the lower down-stream platinum gauze. The purpose of this experiment was to test the idea that possibly the lower gauze, and the asbestos fiber between the gauzes, served only as a heat insulator with possibly the added effect of diminishing eddy currents in the neighborhood of

TABLE V.

Date	Duration of Test Period, Hr. Min.	No. of Samples	Cu. Ft. of Air Per Min.	Av. Per Cent NH ₃ by Volume	Av. Oxidation Efficiency, Per Cent
12/17/18	8 ..	11	20	8.5	97.1
12/18/18	16 10	8	40	8.4	91.9
12/18/18	5 20	6	60	10.8	88.1
12/19/18	1 ..	2	80	9.0	85.0

the gauze. If such were the case, a base metal gauze on the down-stream side would serve as well as a platinum gauze. The results, given in Table V, are perhaps not quite conclusive, but so far as they go indicate that the beneficial results of a double gauze are due partly, but not entirely, to heat conservation and effects other than gauze activity.

USE OF AMMONIUM NITRATE SOLUTION IN ABSORPTION TOWERS

Since the use of air as an oxidizing agent for ammonia automatically sets rather a low limit to the concentration of nitric acid which can be obtained in the absorption towers, it is obvious that it would be very advantageous to circulate a fairly strong solution of ammonium nitrate in the towers, so that on subsequent neutralization of the nitric acid the excess ammonium nitrate would crystallize out. It was first demonstrated

that an ammonium nitrate solution was practically as good an absorbent for nitrogen oxides as is water. Unfortunately, however, the ammonium nitrate solution is rapidly decomposed in the towers and the whole scheme thereby rendered valueless.

CATALYSIS OF THE REACTION BETWEEN NITRIC OXIDE AND OXYGEN BY ACTIVATED CARBON

One of the factors which make it necessary to provide a very large absorption system for the nitrogen oxides resulting from ammonia oxidation (or from arc process) is that the reaction between nitric oxide and oxygen to form nitrogen peroxide is relatively slow. Dr. C. L. Burdick had studied the catalytic effect of activated carbon on this reaction, working with small samples of carbon in the laboratories at Massachusetts Institute of Technology, and had obtained very promising results. In June, 1918, Dr. Burdick was assigned to the Sheffield Experiment Station, where facilities were available for trying the reaction on a semi-commercial scale.

An apparatus was set up using about 125 lb. of carbon catalyst for handling the gases from a square foot of platinum gauze oxidizer and a considerable number of tests carried out. Possibly Dr. Burdick will at some time report the details of these tests. In the present article there is space available for mention only of the general results obtained.

The first difficulty encountered with the large-scale apparatus was the discovery that with a gas containing as much as 10 per cent of nitric oxide initially, the catalyst would promptly burn up. This factor had not been disclosed by the laboratory tests. A variety of experiments were then carried out in attempting to eliminate this difficulty, but it was finally decided to put the first catalyst chamber after the first or second absorption tower, where the nitric oxide content of the gas would be lower. This proved satisfactory, but another difficulty arose in that the bed of catalyst removed so much of the fog from the gas stream that it soon became soaked with weak nitric acid solution and, of course, became inactive. This difficulty was eventually overcome by keeping the gas in the catalyst chamber well above the dew point (about 75 deg. C.) and fairly satisfactory results were finally obtained. It was found that with a total nitrogen oxide content in the gas from 1.5 to 2 per cent, under the conditions of the test, the rate of oxidation with the catalyst was, on the average, about fourteen times as great as when no catalyst was present. There is no doubt that the scheme has commercial possibilities, but there are some engineering features to be worked out in its practical application.

A FEW OF THE UNSOLVED PROBLEMS CONNECTED WITH THE CATALYTIC OXIDATION OF AMMONIA

1. *More Economical Use of Platinum Catalyst.* While platinum gauzes have been the most successful form in which platinum has been utilized as an ammonia catalyst, at least in this country, it is very likely that the present practice is not the most economical way in which platinum can be used as ammonia oxidation catalyst. The matter of wire diameter and gauze mesh has not been placed on a scientific foundation. It has been largely a case of one plant copying what has been successfully used elsewhere. At the present time, commercial practice is settled on a wire diameter somewhere in the neighborhood of 0.003 in. and a mesh of about 80.

There are ample reasons for believing that this does not represent the best wire diameter and mesh. The matter of wire diameter has been somewhat fixed by the fact that it is not easy to draw pure platinum into wire finer than 0.003 in. diameter. At one time the erroneous idea prevailed that the platinum must be iridium free. This idea has been dispelled, and with the use of a little iridium in the wire it is possible to draw the platinum considerably finer. There is considerable leeway possible in the matter of gauze mesh.

Aside from the use of platinum in the form of a gauze, European investigators and possibly a few in America have tried perforated platinum foil, corrugated platinum and various other forms. None of these, so far as is known, has any advantage over the platinum gauze. It must be remembered, however, that in a gauze woven of platinum wires a considerable amount of the platinum in the interior of the wires is not active. The formation of a mossy surface on the wires very greatly increases the effective surface of the platinum, but a microscopic examination of the wires, even after they have been in use for several months, revealed a solid core of platinum in each wire which is obviously not effective in the ammonia oxidation. Numerous attempts have been made, both in this country and in Europe, to use platinum deposited on either base metal wire or on refractories such as aluminum, quartz, etc. So far as is known, none of these catalysts has been used commercially, but there is no reason to believe that success will not ultimately attend these efforts, and certainly the use of a very thin layer of platinum deposited on the surface of some refractory material which does not decompose ammonia would appear to be a better way of utilizing platinum than the ordinary gauze.

2. *Non-Platinum Catalyst.* It is well known that platinum is not the only material which will bring about the catalytic oxidation of ammonia to nitric oxide, and numerous attempts have been made to substitute cheaper materials for the costly platinum. A number of the base metals will oxidize ammonia to nitric oxide with an efficiency of, say, 70 per cent. There are also a number of oxides such as nickel, cobalt, chromium, etc., which are fairly effective in the catalytic oxidation of ammonia. The General Chemical Co. claims to have a non-platinum catalyst which operates at an efficiency of 92 per cent in an experimental plant. However, the fact remains that none of these non-platinum catalysts has been operated successfully on a commercial scale, and it is to be said of most of the experimental work that the oxidation efficiencies obtained have been hopelessly low. It must be remembered, however, that when platinum itself was first used as an ammonia oxidation catalyst, the efficiencies obtained were rather low. Even at the time the United States entered the war the oxidation efficiency actually obtained by platinum gauzes in daily use was not above 80 per cent, and there is no reason for believing that the efficiency of non-platinum catalysts could not also be increased by a further study of such catalysts.

3. *Use of Multiple Gauzes.* During the course of the experimental work carried out at this station it was shown that if two platinum gauzes be mounted in the converter at a distance of about $\frac{1}{4}$ in. from each other, but insulated from each other by a loose layer of pure asbestos fiber, there was thus obtained an ammonia oxidation apparatus which was much more efficient than

the ordinary flat gauze type. With this arrangement it was necessary to heat only the upper, or up-stream, gauze. The capacity per square foot of platinum was more than 50 per cent greater than for the platinum used in the ordinary flat gauze and, moreover, the oxidation efficiency was also raised. It was found further that if a base metal gauze were substituted for the lower platinum gauze the apparatus still had considerably greater capacity and higher oxidation efficiency than the single platinum gauze ordinarily used. The success of these experiments certainly warrants further research in the matter of using combinations of gauzes with electrical heat only on the up-stream gauze, the assumption being that the heat of the reaction is sufficient to maintain the other layers of gauze at operating temperature. It should be mentioned, of course, that with a double gauze combination, electrically heated on only one gauze, the electrical power consumption is only half as great as would ordinarily be used for the same area of platinum. There is a further possibility that a combination of platinum gauze with a non-platinum catalyst could be successfully used. For example, if the lower gauze in the above combination should be replaced by a non-platinum catalyst, it is quite possible that the non-platinum catalyst would be efficient enough to clean up any ammonia passing through the platinum gauze.

4. *Relation of the Factors: Ammonia Content of Gas, Gauze Temperature, Rate of Gas Flow Through Gauze, and Ammonia Oxidation Efficiency.* The Sheffield Experiment Station contemplated a complete study of the relation which exists between the factors listed above. However, the press of other experiments did not give sufficient time to complete the investigation. It was shown that regardless of the ammonia content of the gas, the heat developed by a single flat gauze, operated without electrical heat, is not sufficient to maintain the gauze at the optimum operating temperature. In spite of all the experimental work which has been done on ammonia oxidation by means of platinum gauze, it is the belief of the writer that the relation between the above factors has not been established on anything like a scientific basis. It is rather difficult to maintain a sufficient number of factors constant in studying the problem, and this difficulty increases somewhat in proportion to the area of the gauze used. It is thought that the problem should be attacked on a laboratory scale with a gauze measuring, say, 3x6 in. and with sufficient provision for heating the gauze electrically up to its melting point, with means for providing a very steady flow of gas and for controlling the ammonia content accurately. It is thought that the result of such experiments would throw considerable light on the actual behavior of platinum as an ammonia catalyst.

5. *Increasing the Oxygen Content of the Gas Mixture Ahead of the Gauze.* It has been frequently suggested that in place of using air and ammonia, it would be an improvement to use an air-ammonia mixture enriched with oxygen. This point is particularly well taken in view of the fact that ammonia oxidation may very likely be carried out in connection with plants where waste oxygen is available as, for example, in a cyanamide plant. There is, of course, a limit to the amount of oxygen which can be introduced because of the fact that ultimately the mixture becomes explosive. At-

tempts have been made to pass beyond this lower limit of explosibility by adding steam to the mixture. The obvious step would be to eliminate the nitrogen entirely and use an ammonia-oxygen mixture in the exact proportions to form either nitric oxide or nitrogen dioxide, preferably the former. The explosion which would ordinarily occur could then be damped out by means of steam, the steam being condensed beyond the gauze, leaving the pure nitric oxide, which could then be enriched with enough oxygen to form ultimately only nitric acid in the absorption towers. This would entirely avoid the dilution of the nitrogen oxides by the nitrogen and the tower losses would certainly be reduced, since this dilution by nitrogen is one of the factors which renders the absorption of the nitrous gases in the towers difficult. This scheme of using oxygen, ammonia and steam has, it is understood, been suggested in Europe and some experiments along this line have been made. Complete data are lacking.

6. *Apparatus for Continuous Analysis of Gas Mixtures.* Instruments for continuously recording the ammonia content of the air-ammonia mix passing to the catalyst and the nitric oxide content of the gas leaving the catalyst chamber would be very desirable in a plant. The ammonia analysis instrument should be fairly easy to devise.

7. *Catalysis of the Oxidation of Nitric Oxide to Nitrogen Peroxide.* The principal reason for the difficulty encountered in the absorption of nitrous gases by water is the fact that the oxidation of nitric oxide to nitrogen peroxide is a rather slow process. The absorption of nitrogen dioxide by water results eventually in the liberation of more nitric oxide. This fact results in the liberation of nitric oxide all the way through the tower system, so that obviously 100 per cent absorption is theoretically impossible, although it may be approached sufficiently near by making the absorption train large. This nitric oxide which is liberated must be oxidized again to nitrogen dioxide before it can react further with water, and obviously the slow rate of oxidation of nitric oxide to dioxide, while the gas is meanwhile being swept through the tower system, necessitates the building of a very large absorption system in order to get a reasonable recovery of the fixed nitrogen.

The use of activated carbon for catalyzing this reaction has already been described. On account of the inherent disadvantages of this carbon, however, it would be well to develop other catalysts.

Iron Ore Production in France

During the year 1921 14,106,063 metric tons of iron ore was mined in France, as compared with 13,846,122 metric tons in 1920, an increase of 259,946 metric tons, or 1.8 per cent. In 1913 French iron ore production amounted to 21,917,870 metric tons, to which amount should be added 21,136,265 metric tons produced in the Metz-Thionville basin, which was German at the time. The 1921 output represents only about one-third of the production realized in 1913 within the present boundaries of France.

Statistics of production show a noticeable decrease in the monthly tonnage per man. Previous to the war the monthly production of a French miner was 71.6 metric tons in 1920, an increase of 259,946 metric tons. In 1913 the German miner in the Metz-Thionville basin was credited with a monthly average of 109.7 tons.

Metallic Tantalum Now Commercially Available

AS A RESULT of research extending over a period of 6 years, the Fansteel Products Co. of North Chicago, Ill., has developed a process for the production of metallic tantalum. It was felt that certain characteristic properties of this element—particularly the combination of its softness and workability with its extreme resistance to wet corrosion—would make it a valuable material in American technology. The following information regarding this interesting new commercial metal will supplement the brief reference made in *Chem. & Met.* for June 14, 1922, p. 1141.

No tonnage uses of the material can ever be expected, as it must be manufactured in an atmosphere free from oxygen, hydrogen, nitrogen and other common gases. It is, as a matter of fact, made *in vacuo*, which, of course, will make its price excessive for use as an ordinary metal.

RESISTANCE TO WET CORROSION

Its resistance to wet corrosion is its most obvious characteristic. It is unattacked by any acid or alkali solution even at boiling temperatures, excepting hydrofluoric acid and its mixtures with other acids. It is unattacked by aqua regia.

Electrically also it has some interesting properties, the most novel of which is its valve action in electrolytic cells, a property which it holds in common with aluminum. A dielectric oxide is readily formed on its surface, which makes it useless as an anode in electrolysis, as no direct current will pass. This property, however, permits its use in electrolytic rectifiers for alternating current, where it has the apparent advantage over aluminum of its extreme chemical resistivity, which permits a wide choice of electrolytes.

COMBINES WITH GASES AT HIGH TEMPERATURES

Its high melting point, about 2,850 deg. C., is of no commercial advantage, except where the atmosphere may be made to exclude the gases which will combine readily with it. In its combination with gases at elevated temperatures it forms stable compounds which are not readily dissociated into the gas and pure metal below the melting point. No very close study of its action in gases has been made and it is impossible to say at the present time if it is selective in its action or whether it continues to take up gas at all temperatures to its melting point, or whether it will release certain gases at high temperatures *in vacuo*.

Tantalum has not been available in the United States since 1914, when the German source was cut off. The possibilities of its utility will now be very much greater than they were in 1914, as the various electrical arts, particularly those requiring high melting point materials and use *in vacuo*, have been very largely developed since that date.

PROPERTIES TO BE STUDIED FULLY

No very reliable list of all of the properties of tantalum has been compiled to the present writing, but steps are being taken to make a complete scientific investigation of the properties of the pure material.

All of the work in the development of a commercial process for the manufacture of pure American tantalum has been done for the Fansteel company by Dr. Clarence W. Balke, the company's research director. Dr. Balke has always been interested in tantalum and

its sister metal columbium, since he determined the atomic weights of these materials, working under Dr. Edgar F. Smith at the University of Pennsylvania. These determinations, made about 10 years ago, are still accepted in the international table of atomic weights.

WORK ON COLUMBIUM UNDER WAY

Further research work is being conducted by the Fansteel company on columbium with a view to determining what commercial advantages this material may have.

The sources of raw material occur in the United States chiefly in the form of columbite, although a certain amount of tantalite is available. Hitherto stocks of the material have come from Australia, where excellent grades of ore are still obtainable.

Volatilization of Copper at Low Temperatures

In a recent research on decarbonization of steels a piece of medium-carbon steel was fixed to a copper support by a pure iron wire and heated for 4 days in a stream of dry hydrogen at about 800 deg. C. When the furnace was opened, the steel was tightly welded to the copper, and everything was covered with a bright copper plate. A microscopic view showing the wire binding is shown in Fig. 1. Evidently the iron wire

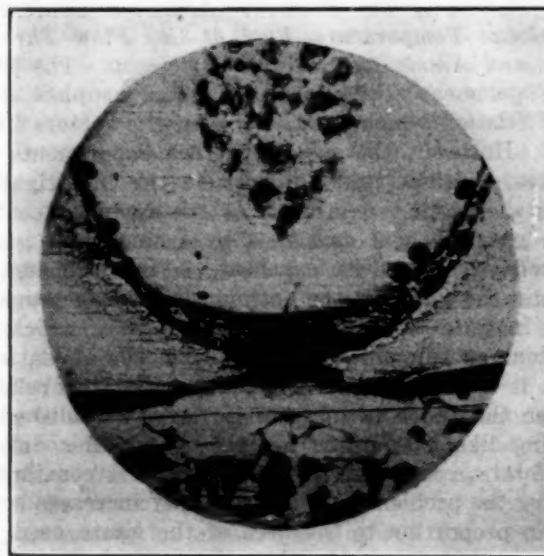


FIG. 1—MIGRATION OF CARBON AND COPPER IN HYDROGEN AT 800 DEG. C. (X 100)

had first been carbonized throughout to approximately the carbon content of the steel sample, whereupon the decarbonization of both steel and its fixture ensued. Meanwhile a thin film of copper had deposited (vaporized from the copper support) and alloyed, the alloy later being covered by a layer of substantially pure copper.

Small Cottrell Precipitator

The Research Corporation has designed a new so-called "BL" unit type of precipitator, applicable to dust recovery. It is lighter, smaller, more compact and simpler to install than the old type, and is available in capacities up to 25,000 cu.ft. per minute. It is shipped ready to set up.

"Hydrogen Decarburisation of Carbon Steels, With Considerations on Related Phenomena," Charles R. Austin; British Iron & Steel Institute (1922).

Synopsis of Recent Chemical & Metallurgical Literature

Surface-Coated, Photographic, Cigarette and Miscellaneous Papers

The United States Tariff Commission has just issued a report entitled "Surface-Coated, Photographic, Cigarette and Miscellaneous Papers." This report is one of a series to be published by the commission dealing with different kinds of paper. In structure it follows the general outline of all the tariff information surveys prepared by the commission, the aim of which is to present to Congress in detail sifted data that may serve as a guide in framing scientific tariff legislation. These data relate to description of the different varieties of paper, raw materials used, processes of manufacture, volume and value of production, imports, exports, prices, tariff history, nature of competition with foreign countries, customs decisions, etc. The papers considered are surface-coated, waxed, gummed, decalcomania and decorated paper; cloth-lined or reinforced paper; photographic and blueprint paper; cigarette paper; papier-mâché; paper not specially provided for in the tariff law; miscellaneous manufactures of paper, such as bags and boxes; and paper stock.

Electrodeposition of Iron

A 50-page bulletin has been written for the British Department of Scientific and Industrial Research on "Electrodeposition of Iron," by W. E. Hughes.¹ In it he describes eight different types of deposits—viz., normal, columnar, mosaic, poplar-tree, fibrous, fan, cauliflower and fountain. Most of these names are self-descriptive and applicable to various electrodeposited metals. Normal deposit is most frequent; in it many prominent grains have a V shape, pointed inward toward the cathode.

Using a current density of 120 amp. per sq.ft., a 2½-gal. bath of neutral ferrous chloride², depositing for 2 hours on a cleaned copper rod, the effect of varying temperature from 70 to 116 deg. C. is as follows: As temperature increases the surface becomes rougher and the grain becomes coarser, the deposit softer and less brittle. (It is a quite general rule that the more coarsely crystalline the surface is the larger the grain size of the metallic deposit.)

Maintaining the temperature at 110 deg. C. and varying the current density from 60 to 240 amp. per sq.ft. gave results indicating that a maximum grain size is reached at about 120 amp. per sq.ft. and a minimum exists at about 200. Heavier densities again

coarsen the grain. As before, coarse grain is associated with softness and lack of brittleness; the metal can be safely hammered while cold.

A great and striking difference exists between two deposits made under like conditions except that one contains a rotating cathode. The latter surface is extremely smooth and the metal is very much finer in grain, often approaching a fibrous structure when sectioned and examined under the microscope. It is also characteristically hard and brittle.

Adhesion of the deposit depends upon absolute cleanliness of the cathode. This involves boiling in an alkaline cleanser, treatment by an electro-cleaner, and dipping in 10 per cent HCl, with appropriate scrubbing and rinsing between.

A small quantity of free acid will generally cause an iron deposit to be fine grained to fibrous, even if made at low current density. Furthermore, the solutions must not become materially depleted in iron content if thick, uniform deposits are desired.

Use of Rubber in Paper Making

Engineering, London, for Sept. 8, 1922, comments editorially on the interest which is being taken in the research work of S. Kaye on the addition of rubber latex to paper stock during the beating operation for the purpose of improving the strength and quality of the paper. Representatives both of the rubber industry and the paper manufacturers were present at a recent meeting of the Rubber Institution, when Mr. Kaye read a paper entitled "Rubber Latex in Paper Making." The amount of rubber which actually enters into the constitution of the paper is very small indeed, but in some unexplained way the addition of the latex appears to assist the hydration of the cellulose fibers, with a consequent reduction in the time required for beating and the power consumed.

The article emphasizes a point brought out during the discussion by a speaker who suggested that since the beneficial effect of the rubber is not due to its rubbery nature but to the colloidal properties of the latex, further investigation might disclose some more easily procurable colloid which would have the same effect. This, of course, is merely speculation, as the mechanism of the acceleration of the hydration of the fiber by the latex is not understood. Several possible developments of the process were indicated at the meeting, such as the production of waterproof containers for packing liquid and semi-liquid substances. The dyeing of rubber-treated paper has not been found difficult, even when the rubber content amounted to as much as 30 per cent. Rubber-treated paper bears up well under rigid tests for durability. It was also suggested that where a rubber content of 5 per cent or more was used, it might be found advantageous to vulcanize it, as the paper would be rendered stiffer and stronger.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Cellulose Ester Solvent—Carbon tetrachloride as a solvent for cellulose ethers for film base is covered by a patent assigned to the Eastman Kodak Co. by William R. Webb, of Rochester, N. Y. It is claimed that a solution of the proper viscosity for casting may be obtained by using a mixture of tetrachloride and ethyl alcohol. The specification covers solvent mixtures ranging from 5 to 95 parts of carbon tetrachloride and 95 to 5 parts by weight of ethyl alcohol, although the ratio 60:40 tetrachloride:alcohol is mentioned specifically. (1,418,413. June 6, 1922.)

Greaseproof Paper—The use of sugar as a coating for paper containers to render them greaseproof is covered by a patent taken out by Wilbur L. Wright, of Fulton, N. Y., and assigned to the Sealright Co. The idea is based on the fact that various compounds included under the general term sugar are harmless commercial products, cheap and not appreciably soluble in oils and other greases, particularly food products, and that hence if paper can be coated with an unbroken or impervious coating of sugar, or if the fibers and body of the paper can be completely filled or impregnated with sugar, this treatment will constitute a barrier against the passage of grease. Gelatine is used as a medium for the sugar, and a hygroscopic ingredient such as glycerine and a hardener, such as alum, are also added to the treating solution. It is claimed that paper covered with this material dries quickly, producing a bright smooth surface that is hard and not sticky, that is flexible and more or less elastic, is tasteless, odorless, colorless, and does not cause harmful action in food products put up in such packages. (1,417,708. May 30, 1922.)

Naval Stores—An apparatus for the extraction of turpentine and rosin from pine stumps is covered by a patent taken out by Jerry M. Jordan, of Crestview, Fla. The apparatus is merely a closed retort surrounded by a water jacket. A firebox is provided which boils the water in the jacket and keeps the retort surrounded by steam. The inventor claims that it is possible by the use of this apparatus to obtain turpentine from waste pieces of wood, slashings, dead wood, etc., and that a large amount of turpentine can be obtained cheaply from tracts of timber where the turpentine has been extracted in the usual fashion and which would otherwise be worthless. (1,424,248. Aug. 1, 1922.)

The Vulcanization of Rubber—Paranitroso-di-methyl-aniline is a poison

¹Published by His Majesty's Stationery Office, London. Price 6s. 8½d.

²Concentration not noted; possibly Merck's solution (100 kg. FeCl₂ to 100 liters water.)

and because of this fact its properties of accelerating the vulcanization of rubber are not extensively used. Bedford and Sibley, of Akron, Ohio, have discovered that this compound will react in an organic solvent with hydrogen sulphide to produce a substance with strong basic properties. This substance has the same accelerator effect on rubber that paranitroso-di-methylaniline has. It is quite odorless and can be stored for a long period of time without danger of poisoning those in the vicinity. (U. S. Pat. 1,418,771.)

Available Potash From Leucitic Rock—Dr. Blanc and N. Felix Gourdan, of Rome and Paris respectively, have taken out a patent to render the potash in leucitic rock available at considerably less cost than the present process. At present, it is necessary to grind the rocks and treat them with strong mineral acids such as hydrochloric acid, but when large quantities of material are employed, the process becomes extremely expensive. The potash in leucitic rock is combined in such a way as to be rather readily separated from its silicic acid component. By grinding the rock to an impalpable powder, the authors declare that not only strong acid but weak mineral acid and even organic acid will attack the potash and make it soluble. It is actually accomplished by means of carbonic acid (CO_2). The potassium carbonate thus formed can be readily washed from the insoluble material, or the leucitic rock can even be used as a fertilizer ingredient directly without lixiviation. In order to accomplish more easily the breaking up of the leucite, the rock is first calcined in the presence of steam or with quicklime magnesia, etc. The calcined material is then introduced after grinding into the treating apparatus. It is extremely interesting that fine grinding has made weak acid effective in breaking down the leucitic rock. (U. S. Pat. 1,418,356.)

Method of Purifying Carbon—Victor Lenher, of Madison, Wis., and Frank M. Dorsey, of Cleveland, Ohio, are the co-authors of this extremely interesting patent. A much more porous and much purer charcoal is obtained by this process than is possible by a simple activation. The activation process, of course, consists in heating charcoal in the presence of superheated steam to from 700 to 1,100 deg. C. This produces a porous structure, but is not nearly as desirable an article as the product which is prepared by this new method.

The carbon first is heated with selenium oxychloride. Selenium oxychloride at room temperature or as high as 50 to 100 deg. C. is first used and this dissolves many of the impurities and forms a very porous structure of very pure carbon. The selenium oxychloride must be removed, however, and this is accomplished with either carbon tetrachloride or chloroform. (In fact, it is found desirable to dilute the selenium oxychloride in the first place with about 25 per cent of carbon tetrachloride.) The residue of carbon tetrachloride is

then distilled out of the carbon and recovered. (1,423,231; assigned to the General Electric Co., New York. July 18, 1922.)

Rubber Accelerator—Benjamin D. Porritt, of Edinburgh, has taken out a patent for the use of monohydroxy nuclear substances, such as phenol or its analogs. In other words, he takes about 2 per cent sodium phenate with ninety parts of rubber and ten parts of sulphur. This addition reduces the vulcanization time more than 75 per cent. (U. S. Pat. 1,418,166.)

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Tanning—Hides and skins are tanned by means of soluble magnesium salts and soluble carbonic acid salts of other bases in the presence of water. A mixture of the dry salts may be introduced into a drum containing the wet hides, the moisture being sufficient to dissolve the salts and render them active, or the hides or skins may be drummed successively in separate solutions of the salts. The process may be applied to partly tanned hides, or may be combined with other processes such as tanning or treatment by cellulose sulphite liquors, formaldehyde, chrome, iron or other mineral tanning agents, or vegetable tanning agents, used in admixture or separately. In an example, 100 kg. of unhaird hides is drummed for 4 to 6 hours or longer in a concentrated solution containing 21 to 22 kg. of magnesium sulphate and 7 kg. of sodium bicarbonate or 9 kg. of sodium carbonate, or the hides may be first drummed in a solution of one of the salts, the other salt being added subsequently. This treatment may be followed by rinsing and oiling or by treatment with fat, grease, etc., to which formaldehyde has been added, or the hides may be pressed out or exposed to the air, then coated or brushed over with cellulose sulphite liquor and afterwards rolled and greased. Alternatively the cellulose extract may be added to the tanning mixture. Formaldehyde, chrome alum or salts of iron, zinc or barium or small quantities of vegetable tanning materials such as oak extract may be added to the tanning mixture described in the example or may be employed in separate solutions for subsequent treatment. In a further example the hides, after treatment with the mixed salts and formaldehyde, are steeped in milk of lime and then further treated as in the first example. The various processes are stated to produce heat-resisting qualities, durable graining or embossing, etc., firm or soft texture as required. (Br. Pat. 180,758; J. Hell, Wurttemberg. July 26, 1922.)

Lead Chromate Pigment—Lead chromate for use as a pigment is obtained by treating lead sulphate, preferably freshly precipitated, with an equivalent quantity of a soluble normal chromate such as sodium or ammonium chromate. Paler yellow pigments are obtained by

using smaller quantities of the soluble chromate, products of the composition $\text{PbCrO}_4 \cdot \text{PbSO}_4$ and $\text{PbCrO}_4 \cdot 2\text{PbSO}_4$ being mentioned. (Br. Pat. 182,693. H. Hetherington and W. A. Allsebrook, Matlock Bath, Derbyshire. Aug. 30, 1922.)

Bleaching—Loose cotton and cotton yarns or fabrics, etc., are bleached by first treating the goods with a soda lye containing soluble hydrosulphites, preferably in a vacuum at temperatures below 100 deg. C., and then bleaching by means of other bleaching agents, such as hypochlorites, hydrogen peroxide, perborates, percarbonates, persulphates, etc. Sodium or ammonium hydrosulphites may be used, and the goods may be scoured and washed during the bleaching process. (Br. Pat. 182,776; not yet accepted. C. Bochter, Gönzburg. Aug. 30, 1922.)

Ethers and Esters—Ethers and esters of ethyleneglycol and vinyl alcohol are produced by passing acetylene together with the vapor of compounds containing hydroxyl or carboxyl groups over heated catalysts, especially metals, their oxides and salts. Examples of suitable catalysts are cadmium, zinc, mercury, magnesium, barium, copper, silver, cerium, nickel and iron, or their compounds, preferably mounted on a support such as charcoal, pumice or infusorial earth. The reaction may be carried out under increased or reduced pressure; and is preferably conducted as a cyclic process, the unchanged hydroxyl or carboxyl compound being continuously separated from the product and returned with fresh acetylene into the reaction chamber. According to the example, equal volumes of acetylene and acetic acid are passed at a temperature of 200 deg. C. over charcoal impregnated with cadmium acetate; ethylidene diacetate is isolated from the condensed product. (Br. Pat. 182,112; not yet accepted. Consortium für Elektrochemische Industrie Ges., Munich. Aug. 23, 1922.)

Cyanamide Residues—The residues resulting from the decomposition of calcium cyanide by acids to obtain assimilable nitrogen compounds are converted into industrial products such as nitrogenous manures, lime and carbon dioxide. If carbon dioxide or sulphur dioxide is employed as the acid, the residues contain calcium carbonate or sulphite carbon and impurities. According to one process they are air-dried and mixed with solutions of urea, urea salts or any assimilable nitrogenous compounds obtained from calcium cyanamide. In an example the residue from the carbon dioxide process is air-dried and mixed with a solution of urea sulphate and the whole evaporated to obtain a manure. The residue from the carbon dioxide process may also be employed instead of a mixture of limestone and coke to obtain quicklime and carbon dioxide. In this case the air-dried residue is either calcined directly or briquetted and calcined. Additional oxygen may be introduced into the furnace. (Br. Pat. 182,134; not yet accepted. Soc. d'Etudes Chimiques pour l'Industrie, Geneva. Aug. 23, 1922.)

Titanium Catalyst for Hydrocarbons—Aromatic hydrocarbons are oxidized by passing their vapor admixed with air or oxygen over a catalyst consisting of or containing titanium compounds—for example, titanium oxide or brick rich in titanium. The presence of nitrogen oxides assists the oxidation; steam or other inert gas may also be added. The catalyst may be supported on a carrier, such as brick, asbestos or pumice. Examples are given of the oxidation of anthracene to anthraquinone and of naphthalene to phthalic acid and phthalic anhydride. (Br. Pat. 182,843, F. W. Attack, of British Alizarine Co. Ltd., Manchester. Sept. 6, 1922.)

Book Reviews

RAYS OF POSITIVE ELECTRICITY AND THEIR APPLICATION TO CHEMICAL ANALYSES. Second Edition. By Sir J. J. Thomson, O.M., F.R.S., 237 pp. New York: Longmans, Green & Co. Price \$5.25 net.

The appearance of the second edition of this well-known monograph in the series of monographs on physics, of which the author is the editor together with Prof. Frank Horton, will be welcomed by a wide circle of readers. The second edition contains much new material, the size of the first edition having been doubled. Besides the value it possesses for physicists and those especially engaged in the problem of the conduction of electricity through gases, it presents a particular interest for chemists through its direct bearing on the constitution of atoms, molecules and gaseous ions.

The author states in the preface to the new edition: "I have paid special attention to those properties of the positive rays which seem to throw light on the problem of the structure of molecules and atoms and the question of chemical combination. The hope expressed in the first edition that the method of positive rays would be of service in connection with important chemical problems has been fulfilled to a remarkable extent by the researches of Mr. Aston and others on the determination of atomic weights and the detection of isotopes. I am convinced that as yet we are only at the beginning of a harvest of results which will elucidate the process of chemical combination, and thus bridge over the most serious gap which at present exists between physics and chemistry."

Besides a full discussion of theory and descriptions of experimental details, including Aston's focus method and Dempster's method, the text is replete with a judicious weighing of evidence for and against the assumption of the existence of isotopes. The author makes it very clear that he has maintained an open mind on this subject and that he does not accept as final the proofs hitherto adduced which have appeared conclusive under a less searching analysis. The possibility

that the isotopes of neighboring atomic weights may prove to be hydrides of the ordinary atoms is given the most careful consideration. While there is strong evidence against this assumption, the author does not dismiss it without a thorough examination.

The concluding pages are devoted to the opportunities of future application of positive rays in studying molecules and the mechanism of their structure, and strong recommendation is made for the method as a means of spectroscopic analysis much simpler and more definite than ordinary spectroscopy. The field is one which should not be neglected in experimental chemistry, and, as the author points out, involves, in its simpler applications, neither a complicated apparatus nor a difficult technique.

S. C. LIND.

ORGANIC CHEMISTRY, OR CHEMISTRY OF THE CARBON COMPOUNDS. By Victor von Richter. Vol. II, Chemistry of the Carbocyclic Compounds, edited by Prof. R. Anschütz and Dr. H. Meerwein. Translated from the eleventh German edition by E. E. Fournier D'Albe, D.Sc., A.R.C.Sc. xvi + 760 pp. Philadelphia: P. Blakiston's Son & Co. Price \$8.

Richter's Organic Chemistry needs no introduction to organic chemists. To others mention of the fact that it has passed through eleven German and three American editions is sufficient introduction. Richter's text has been enlarged so much in order to make it complete that it is now a compendium—a sort of abridged Beilstein—rather than a class text. This fact does not, however, detract from its usefulness in advanced classes, especially for certain topics—for example, the terpenes—and as a handy reference book.

The eleventh German edition was published 10 years ago and therefore some of the very recent developments are not included in the volume under review. Yet the book contains an abundance of material which is well classified, well described and well illustrated with examples. This second volume is a good translation of the major portion of the German second volume. It treats of the following subjects: cyclo-paraffins, cyclo-olefines, general aromatic chemistry—benzene, its homologs and their numerous derivatives, hydro-aromatic compounds, terpenes, naphthalenes, anthracenes, etc., glucosides, bitter principles, and natural dyes, the last three only very briefly. The part covering the heterocycles is omitted and probably will appear as a third volume. Some idea of the number of compounds discussed in the present volume may be obtained when it is mentioned that the index covers thirty-one full pages, two columns to the page and seventy-five lines to the column.

The translation is clear and generally accurate, and the arrangement of the work is admirable. The typography is excellent, better than in the first volume. The name of each compound

when first described is emphasized by being printed in bold-faced type.

A somewhat careful reading of a goodly portion of the text brings out a few errors and raises some questions which require comment. In the spelling of names and radicals the translator is not always consistent or correct according to the best usage. "Benzene" and "benzol" sometimes alternate in the same sentence or paragraph, and the homologs of benzene, except mesitylene, are given the suffix "ol" instead of "ene." The obsolete term "amido" is found here and there in place of "amino" (pp. 382, 406), and "amine" as a name and the names of amines such as toluidine in a few instances have no final "e." This spelling shows a direct transcription of the name rather than a tendency to shorten the ending. Similarly with naphthalene and some of its derivatives, which are frequently given the less useful ending "in." The translation of "Benzolkohlenwasserstoffe" in the heading (p. 49) as "Benzene Carbohydrates" instead of "Benzene Hydrocarbons" is unfortunate. It often seems that the translator is endeavoring to vary the names or their spelling in order to avoid monotony but, commendable as this practice is, clearness and accuracy may be sacrificed by so doing. He naturally uses the English spelling in such words as "oxidised," "colour," etc., although the book is printed in Philadelphia. "Nitrogenation" (62), "nitrogenated" (67), "nitrifying" (107, 170, 416) and "nitrified" (445) are neither correct nor advantageous terms for nitration, nitrated, etc., which are properly used in many other places. The reviewer believes that if another word is to be substituted for nitration where the introduction of a nitro group is meant, "nitronation" would be more satisfactory, since it is definite and corresponds to the term sulphonation in the type of reaction as well as the name. The terms "rejection" (95, 106, 108, 116, 208) and "discarding" (448) used in connection with water, carbon dioxide, etc., do not carry the meaning conveyed by "elimination" or "separation," and certainly are not in good usage, nor is "acetyling" (166) for acetylation, and "water vapor" for steam. Translation of the German plurals as "phenolene" (61) for "phenols," and "alkylene" (116) for "alkyls" is very puzzling at first. A number of structural formulas have a dot or line missing. The formula for heptachloro-resorcin (460) is incorrect in both original and translation, several formulas mentioned in the text on p. 514 have been left out, and there is a mix-up in the translation referring to 1,4-anthraquinone (705). The typographical errors are really few in such a difficult piece of work.

The comments given above are not meant in the least to detract from the real service which the translator and publishers have rendered in giving English-speaking chemists this standard and important work in their own language.

HARRY L. FISHER.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields
Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Fine Chemical Manufacturers Will Appeal for Tariff Rate Changes

Will File Applications Under Flexible Tariff Provisions—No Difficulties in Administering New Rates

PRESSURE already is being brought by those interested in the synthetic organic chemicals not of coal-tar origin to have early hearings before the Tariff Commission with a view toward securing an increased rate on many of the chemicals embraced in paragraph 5 of the tariff act. The manufacturers of these chemicals believe the rate provided in the new law is entirely inadequate, particularly for the fine chemicals of high value. This also applies to the medicinals.

Regulations under which applications for changes in tariff rates may be filed under the flexible tariff section of the new act are expected to be issued by the Tariff Commission about Oct. 11. A committee of the commission is conferring with its legal department regarding the rules and the methods of procedure. Precedents established by the Federal Trade Commission and the Interstate Commerce Commission for complaints and hearings are being studied in this connection.

PROVISIONS FOR RATE CHANGES

Under the Fordney-McCumber tariff act, applications for a change in rates may be filed either with the President or with the Tariff Commission. If filed with the former, they will be referred to the commission for investigation and report. The commission shall report its findings to the President, who thereupon may increase or decrease a rate within a range of 50 per cent. If an increase of 50 per cent be insufficient to equalize the cost of product here and its cost abroad, an ad valorem duty may be transferred to the basis of American valuation, but in this event the figure cannot be changed. A specific rate may not be changed to an ad valorem, nor an ad valorem to a specific. The duty on coal-tar products, placed on American valuation in the act, cannot be increased under this clause.

The Tariff Commission probably will open an office in New York City to conduct some of the hearings and gather the samples and data required of it under the new law, according to announcement of Chairman T. O. Marvin.

Although hard pressed by work, owing to an inadequate force, the customs division of the Treasury Department

has encountered no serious difficulty in administering the new tariff, and, according to Ernest W. Camp, chief of the division, none is expected of an extraordinary nature.

In administering the rates on imports of coal-tar products, which were placed on American valuation in the new tariff, the customs service has taken over the files and records of the Dye and Chemical Control Board, which automatically went out of existence with the effective date of the new tariff which ended the licensing system or so-called embargo. The board had many samples and data which were necessary under the licensing system and which have proved useful in handling the tariff.

NO DIFFICULTY EXPECTED

"We do not expect any great difficulty in administering these coal-tar products rates," said Mr. Camp. "If there is a doubt, we will assess the highest rate that might apply in the case, as provided by the tariff act and as was the law under the old tariff, and an appeal may be had.

"The appeals board may be kept busy, and final liquidations may get congested, but it may be expected that very rapidly there will be established sufficient precedents to remove further difficulties."

CUSTOMS PERSONNEL INSUFFICIENT

The customs division officials expect to work out new regulations as rapidly as cases are called to their attention. Meanwhile, collectors who appeal to headquarters for rulings are being given instructions to admit imports under bonds which will fully protect the revenues pending final liquidation. Thus there will be no delay in getting goods to consignees who are willing to supply bond and await adjudication of their cases.

The most serious handicap in administering the customs is said to be insufficient personnel. This is not a new complaint, but it has been aggravated by change in tariff duties. When the war came and imports decreased heavily, the customs force was reduced from 8,200 to about 6,700. No increase was made when the emergency tariff was imposed in 1921, affecting many imports, and none has been provided

Salesmen's Association Discusses Exposition Plans

To Investigate Claims of Rival Enterprises and Support Management Offering Best Service

A meeting of the executive committee of the Salesmen's Association of the American Chemical Industry was held at the Chemists' Club, New York City, Monday evening, Sept. 25. Those present were: President, John W. Boyer, Williams Haynes, Fred J. Signer, Ray P. Dunning, R. E. Dorland, Walter Goff, J. D. Lowery, F. P. Summers, David Stewart and George T. Short, secretary.

Reply to invitation from Adriaan Nagelvoort, manager of the new co-operative chemical show, was the appointment of a committee to investigate claims of the rival show managements and to report back to the association with recommendations. The sentiment of the meeting was that one show was essential to success and that the exhibits, being in charge of the sales departments of the chemical manufacturers, the Salesmen's Association could render constructive service to the whole industry by sifting the rival claims and throwing weight of their support with the management offering best service to American chemical makers.

F. P. Summers, of the Noil Chemical Co., was named chairman of the membership committee.

SALESMEN'S STUDY COURSE

F. E. Breithut, of the College of the City of New York, outlined a plan for a short night course for chemical salesmen and offered college co-operation in giving such a series of lectures under the auspices of Salesmen's Association. His invitation to hold the next meeting up in the tower of the college was accepted and the date set for Friday Oct. 13. This will be the annual meeting of the New York chapter, at which new local officers will be elected.

for the new tariff. Heavy foreign travel has been delaying ordinary work at some ports because of the necessity of switching inspectors from cargo work and appraisers' warehouses to the inspection of personal baggage.

Representatives of the manufacturing chemical industry have assured Secretary of Commerce Hoover that their flag has been nailed to the mast and that they will continue to do an export business.

Doubt Report That German Dyes Will Pay Bill of Army on Rhine

State Department Did Not Authorize Statement That 5 Per Cent of German Output Will Be Accepted Without Cash Payment

PUBLICATION in the daily press of an article to the effect that the Secretary of State has worked out a plan whereby the cost of maintaining the American army of occupation on the Rhine would be met in part by turning over to the United States its proportion of the reparation dyes without money payment has caused great uneasiness within the dye industry, as is attested by the large number of telegrams which have been received by officials concerned. At the State Department it was asserted positively that no such information had been given out, but Secretary Hughes declined to confirm or deny the statements made in the article.

Dye specialists in Washington are inclined to doubt that any such plan is in contemplation.

The story, which was given some prominence in the daily press last week, stated that Secretary Hughes, after consultation with allied governments, had agreed to permit the United States to receive its share of German dyes without money payment, as has been the practice heretofore, the cost of these dyes to be credited on the American bill against Germany for the army of occupation.

HISTORY OF REPARATION DYES

During the peace conference in Paris there were subsidiary negotiations between the United States and the Allies on the one hand and Germany on the other relative to the exceedingly complicated question of German dyes. These negotiations, extending over a considerable period, were held at Spa and it was agreed that 25 per cent of the total German dye output should be delivered to the Allies on account of reparations. The United States was to receive one-fifth of this, or 5 per cent of the total German output, but since the United States sought no reparations from Germany it was stipulated that this government should pay cash for any dyes received at market prices.

Later, when the question of payment of the United States for the maintenance of its army of occupation on the Rhine arose, Secretary Hughes made it plain that the United States did not propose to be left out in the cold by any arrangement by the Reparation Commission that would interfere with payment by Germany of the cost of the maintenance of the American forces on the Rhine. The justice of the American contention could not be denied and the Reparation Commission finally announced that the matter had been referred to the allied governments for consideration, note being taken by the commission of the American objection to payment of general reparations in advance of a settle-

ment of the costs of maintaining the American army of occupation.

METHOD OF DISTRIBUTION

Before the ratification of the treaty of peace between the United States and Germany the understanding regarding German dyes had not received a clear legal status. The Textile Alliance had been organized for the distribution of German dyes in the United States. The American treaty with Germany, however, specifically guarantees the rights of the United States with respect to the reception of German dyes, and the same treaty further makes it possible for Congress to create a mechanism for handling such dyes whenever received in the United States.

Customs officials state that, unless Congress specifically directs otherwise, dyes imported under such a plan would pay duties charged under the new tariff bill.

Pottery Firms Indicted for Price Fixing

Twenty-Three Companies Charged With Conspiracy to Fix Prices and Stifle Competition

Conspiring in price fixing and unlawful restriction of sales are the two counts charged in an indictment against twenty-three companies, representing 85 per cent of the pottery industry of the United States, and twenty-four men, officers of the same companies.

This indictment is the last of the series resulting from the housing investigation of the Lockwood committee, authorized by the New York State Legislature. It was returned by the July Federal Grand Jury, but on motion of Colonel Hayward, United States Attorney for the Southern District of New York, was held under seal pending further investigation.

CHARGES PRICE FIXING

The indictment charges specifically that the defendants engaged in a price-fixing combination whereby they refrained from competing with one another on a price basis, thus exacting "uniform, arbitrary and non-competitive prices."

The second charge, as explained by Colonel Hayward, involves a practice whereby the defendants were barred, by common consent, from selling their products directly to builders, architects or contractors. All sales, it is alleged, had to be made through so-called "legitimate jobbers." In this manner, according to the District Attorney, prices to the consumer were increased "beyond all reasonable proportions."

STIFLED COMPETITION

After adding a profit, the charge continues, the jobber would confine his

Stansfield to Address Cleveland Iron and Steel Engineers

Prof. Alfred Stansfield, well-known authority on the electric furnace, will be the speaker at the Oct. 9 meeting of the Cleveland District Section of the Association of Iron and Steel Electrical Engineers. Dr. Stansfield has taken as his subject "Electric Smelting of Iron Ores" and will illustrate his remarks with lantern slides. The meeting will be preceded by a dinner at the Cleveland Engineering Society's club rooms at the Hotel Winton.

sales to a so-called legitimate plumber, who would add his profit. After that it would go to the contractor. Each group by this plan, according to charges, was placed in a position to dictate prices and profits without fear of competition.

It is understood that the defendants will be called for pleading within 2 weeks and will be brought to trial soon. The individuals indicted and the companies they represent are as follows:

James E. Slater, president and manager of the Abingdon Sanitary Manufacturing Co., Abingdon, Ill.

James A. Dorety, Jr., secretary of the Acme Sanitary Pottery Co., Trenton, N. J.

Bart O. Tilden, president of the B. O. T. Manufacturing Co., Trenton, N. J.

John W. Bowers, president of the Bowers Pottery Co., Nannington, W. Va.

T. Munro Dobbins, president and treasurer of the Camden Pottery Co., Camden, N. J.

Theodore H. Sharker, secretary and treasurer of the Chicago Pottery Co., Chicago, Ill.

Walter F. Drugan, vice-president of Cochran-Drugan & Co., Trenton, N. J.

Raymond E. Crane, vice-president of the Eljer Co., Cameron, W. Va., and Ford City, Pa.

Edward V. Brigham, vice-president and general manager of the Kalamazoo Sanitary Manufacturing Co., Kalamazoo, Mich.

G. E. Rhodes, general manager of the Kokomo Sanitary Pottery Co., Kokomo, Ind.

Harry J. Lyons, president and treasurer of the Keystone Pottery Co., Trenton, N. J.

Philip J. Faherty, treasurer of the Lambertville Pottery Co., Lambertville, N. J.

William B. Maddock, secretary of John Maddock & Sons, Trenton, N. J.

Archibald M. Maddock, president of Thomas Maddock Sons Co., Trenton, N. J.

Harry F. Weaver, secretary and general manager of the National-Helfrich Potteries Co., Evansville, Ind.

Newton W. Stern, president of the Pacific Sanitary Manufacturing Co., Richmond, Calif.

John F. Smith, treasurer of the Resolute Pottery Co., Trenton, N. J.

(Continued on page 713)

Muscle Shoals Disposal Will Be Revived

Scheduled for Consideration After Recess—Big Power Demand in District

Advocates of acceptance of the Henry Ford offer for the Muscle Shoals project caucused before Congress adjourned and laid tentative plans to renew their effort when the two houses reconvene. Conferences were held with Majority Leader Mondell and others prominent on the Republican side of the House with a view to learning the prospects of having the McKenzie and Wright bills set on the calendar for early consideration. The McKenzie bill provides for acceptance of the Ford bid with the Gorgas steam plant excluded from the property, and the Wright bill would accept the Ford offer with Gorgas included.

Leader Mondell is quoted as having assured the Ford advocates that he saw no objection to having the Ford offer brought on the floor of the House early in the next session, although he pointed out that there is much other important legislation which has been pending for a longer period.

In the last week of the recent session of Congress, the Ford advocates abandoned their tactics of obstructing other legislation in an effort to have the Muscle Shoals bills called up, because it was realized that nothing could be accomplished in the short time remaining. Leaders of the movement declared for an aggressive fight when Congress meets unless the measures are given early consideration.

Hearings also will be asked immediately by Representative Hull on his resolution to refer the whole question of disposition of the Muscle Shoals properties to the Secretary of War with power to act.

SHEFFIELD STEAM PLANT LOADED

Electrical energy being generated at the government steam plant at Sheffield, Ala.—one of the Muscle Shoals plants—is now being sent to the rescue of industry in various communities of southeastern United States, being relayed by intervening systems to aid industry as far as 600 miles away, according to a statement made public in Washington by Thomas W. Martin, president of the Alabama Power Co.

Several thousand miles of high voltage transmission lines are being used, Mr. Martin states, and with the various interconnections in Alabama, Tennessee, Georgia, North Carolina and South Carolina, the system now in use is shown to be the largest in operation in the whole country.

DEMAND FOR POWER

"There is an unusual industrial demand for power in this section," Mr. Martin says. "This, coupled with the coal shortage, the inability to obtain prompt deliveries of coal and the drought, has brought about a serious situation. The water-power plants and reserve steam plants in some parts of

North and South Carolina and Georgia have been unable to take care of the power requirements of cotton mills and other industries in various communities in those states. Therefore, the Sheffield steam plant is now being operated by the power companies for the benefit of the public in the entire Southeast through interconnection of the lines of the companies in the states of Alabama, Tennessee, Georgia and North and South Carolina. The Sheffield plant is nearer the coal mines than other plants and the wheels of industry are being turned again, by that plant, in many far away communities."

The proximity of the steam plants in Alabama to the coal fields of that state makes it feasible to operate them when other plants remote from those fields have difficulty in obtaining fuel. Owing to the fact that this superpower zone is in actual operation at this critical period, several of the largest cotton mills in that section are able to continue at work.

German Sale of Alsace Petroleum Fields Set Aside

The petroleum fields of Pechelbronn (Alsace) were owned, previous to 1914, by two German societies, the Allgemeine Birgemeinengesellschaft and the Deutsch Erdol Aktiengesellschaft. After the armistice the fields were sold by the German societies to a Swiss society, Laterra, which was subsequently consolidated with another Swiss concern, L'Union Internationale des Petroles. The French Government placed the fields under sequestration, their administration being given to the Société Alsacienne d'Etudes Minières. The Swiss societies recently requested the civil court to validate certain attachments of the property of the Société Alsacienne d'Etudes Minières and, on the other hand, the Office des Biens et Interets Privés requested the lifting of the attachments. The court, according to information recently received by the Department of Commerce, has rejected the demand of the Swiss societies, stating that under the terms of the treaty of peace all enemy property was to be under the administration of France, and that the Pechelbronn fields had been unduly sold by the German owners.

Germany Rapidly Restoring Nitrogen Fixation Plants

At the meeting of the British Association held at Hull on Sept. 12, J. A. Harker, in the course of a paper on "Post-War Progress in the Fixation of Nitrogen," said Germany was finding vast sums for the restoration and development of her plant for the fixation of nitrogen. The figures Dr. Harker gave show that in 1913 Germany used 200,000 tons of fixed nitrogen, and by May of this year she was already producing and using at the rate of 290,000 tons per annum. She had by no means reached the limit of her capacity, and by the end of the year he estimates that the output will be at least 500,000 tons.

Time Extension for Chemical Foundation

Month More Allowed for Filing Answer—Situation Complicated by Trademark Clause

The Department of Justice has instructed the District Attorney in Delaware to consent to a 30-day extension of time in which the Chemical Foundation may file its answer to the bill in equity demanding the return of the 4,700 former German patents. The consent was granted on the condition that both parties, the Department of Justice and the Chemical Foundation, cooperate to obtain a speedy settlement of the controversy, which is reaching serious proportions due to the trademark clause in the new tariff bill.

Sept. 28 was the date originally set for the filing of the Foundation's answer. The extension plea was made on the ground that the bill was of such length that more time was necessary properly to prepare its answer. Attorney-General Daugherty, in a statement last week, said that the department realized that more time was essential and that it had no disposition to force the Foundation into trial until it had been given time in which to prepare its defense. If the Delaware court grants the extension, and confidence is expressed that it will, the Chemical Foundation must file its answering plea on Oct. 27.

TRADEMARK CLAUSE TANGLES SITUATION

The government is anxious that the question of title to the patents be settled as speedily as possible. A clause inserted in the Fordney-McCumber tariff bill makes it illegal to import into the United States "any merchandise, if any such merchandise or the label, sign, print, package, wrapper or receptacle bears a trademark owned by a citizen of, or by a corporation or association created or organized in the United States."

Many of the trademarks included in the purchase by the Chemical Foundation are internationally known, and the trademark or trade name could not be changed without losing practically all the old trade. It is generally predicted that the German manufacturers, rather than injure their own markets by changing the trademarks on these products, mostly pharmaceuticals and dyes—will abandon the American market if the Chemical Foundation is victor in the suit.

Officials freely admit that it is a complicated situation and are unwilling to predict the final solution, even if the government is able to set aside the sale.

No More American Caustic for Germany

The demand for American caustic soda in Germany has ceased suddenly according to recent advices to government officials. No report has been received as yet explaining definitely why it became necessary for German interests to purchase such large amounts of caustic soda in this country.

English Develop New Fertilizer From Straw

Valuable Farmyard Manure Produced
by Action of Bacteria on
Cellulose

A process of leading importance in agriculture has been developed by H. B. Hutchinson and E. H. Richards at the Rothamsted Experiment Station at Harpenden in Hertfordshire, England. It consists in producing farmyard manure from straw in the form of humus with its full complement of nitrogen, or about 2 per cent, within 3 months and under easily controlled conditions. The process is patented and experiments are under way in several stations in England to work out the simplest and most available technique. The manure is a well-disintegrated, plastic material in which the tubular character of the straw has been to a great extent destroyed.

HOME MADE FERTILIZER

The maximum results are obtained by subjecting the straw to the action of a culture of aerobic cellulose-deströying organisms with the requisite moisture and the addition of nitrogen as ammonia, diluted urine, urea, ammonium carbonate, ammonium sulphate or cyanamide, to start the reaction. Unless the water is very hard, lime in some form is needed also—that is, soluble nitrogen is supplied at the rate of 0.72 part nitrogen to 100 parts of dry straw. Then little or no loss of nitrogen ensues and the final product contains, as stated above, about 2 per cent. This is also about the same proportion that is contained in the feces of cattle.

An alternative method in which inclosed containers are used and the air supply regulated provides gas (methane) for lighting and driving machinery on the estate of Lord Liveden, but it seems questionable whether the cost of installation to produce this convenience would not be too great for ordinary farm practice.

SUPERIOR PROPERTIES

The extraordinary value of farmyard manure as compared with nitrogen in any other form and the invigorating effect of the added humus to the soil make the discovery of leading importance. Straw of itself is not a useful fertilizer; indeed in many cases it depresses the crop. But once it is decomposed in this manner its value is immediately developed and many pot and field cultures show it to be a true farmyard manure. The straw and the organisms working on it must have abundance of air and just enough but not too much nitrogen. Ordinary urine is too concentrated and destroys the bacteria. Straw immersed in water or in urine will not undergo change. Therefore control of these factors is necessary, although it is believed that processes will shortly be worked out to make any intelligent farmer able to transfer all of his straw into about half its weight of this precious nitrogen-

bearing humus. What the invention may mean to the farmers of the West, for instance, in improving their wheat crop with the aid of a proper manure spreader needs no comment. The same may be said of the wheat farmers of Canada and of the ranchers who burn their flax straw in the Dakotas.

Heat Standard for Gas Is Established in New York

For 15 years there has been a distinct tendency toward adoption of heating value standards for gas quality to replace candle-power requirements. New York City has been the outstanding example where candle-power standards remained until very recently. By order entered on Aug. 30, the New York State Public Service Commission adopted for all gas companies in greater New York a heating value requirement of 537 B.t.u. per cubic foot monthly average, specifying that no daily average should be less than 525 B.t.u. Thus practically the last candle-power requirement of consequence in the country is superseded.

There are two other rather interesting requirements as to gas quality in the commission order. The first specifies that the gas must not contain more than 15 per cent inert constituents. It is doubtless the expectation that this rule will prevent the practice, which has seemed to be particularly prevalent abroad, of making unnecessarily low-heating value gases through excessive vacuum on retorts or slovenly operation with water-gas equipment. The requirement is one of the first where such limit on the total of oxygen, nitrogen and carbon dioxide in a gas has been fixed.

The second novel requirement in this order provides that the heating value shall not have a variation greater than 5 per cent during any 3 consecutive days. This specification is intended to prevent the practice, which has occasionally been found in smaller plants, of running very close to the average requirement until near the end of the month and then bringing up the average by excessively high heating values during the last few days. The result of such practice is, of course, very bad service, because uniformity of quality is of first importance.

The new requirements took effect on Oct. 1.

American Interests Get Oil Concessions in Czechoslovakia

Czechoslovakian official sources announce the formation of a petroleum company having a capital of 100,000,000 crowns. Half of the capital will belong to the government, in exchange for which the Franco-American Standard Oil Co. is granted a monopoly for the exploitation of the oil lands which have not yet been bored. A small part of the capital, about 4,000,000 crowns, will be underwritten by the Credit Bank of Prague, while the remainder will be held by the Franco-American Standard Oil Co.

Power Exposition of Interest to Industries

Show in New York Will Cover All
Phases of Development and
Utilization of Power

Engineers well known in industrial circles make up the advisory committee which is guiding the National Exposition of Power and Mechanical Engineering. This exposition will open at the Grand Central Palace, New York City, on Dec. 7 at noon and will extend through to Dec. 13, except the intervening Sunday. It will immediately follow the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers. Irving E. Moulthrop, of the Edison Electric Illuminating Co., of Boston, heads the advisory committee, and his colleagues are: Dexter S. Kimball, president of the American Society of Mechanical Engineers; Alexander G. Christie, chairman of the power division A.S.M.E.; Fred Felderman, president of the National Association of Stationary Engineers; Milan R. Bump, president National Electric Light Association; N. A. Carle, vice-president, Public Service Production Company of New Jersey; E. B. Katte, chief engineer, electric traction, N.Y.C.R.R. Co.; Fred R. Low, editor *Power*; David Moffat Myers, consulting engineer; Calvin W. Rice, secretary American Society of Mechanical Engineers.

STRESS ENGINEERING FEATURES

This advisory committee is keenly alive to the importance of an exposition that will stress the engineering phases of the problems involved in the economical uses of fuel and the more effectual generation and utilization of power. The effect of such an exposition must be far reaching and the plan outlined by the committee insures a show that will benefit the manufacturer who uses only a small boiler for process steam as well as the engineers of the cement, ceramics, metallurgical and power generation industries, whose fuel and power problems are extensive and severe.

The list of firms which have already reserved space shows that all apparatus and materials used in harnessing the energy released from fuels will be represented. The general appreciation of the importance of the exposition further insures the showing of the newest devices and best methods.

PROGRAM OF MEETINGS

The program for the week has been arranged so that those interested especially in fuels and power can attend the technical sessions on these subjects at the annual meeting of the American Society of Mechanical Engineers. Sessions on ash-handling machinery, stokers and steam utilization have already been announced; others are to come later and it is probable that the papers on these subjects will be amplified by the exhibits at the exposition.

Tax Returns Show Volume of Chemical Business

Over 3,000 Companies in Chemical and Allied Fields Paid Nearly \$100,000,000 in 1920

The net income of the 3,047 corporations engaged in the manufacture of chemicals and allied substances for the calendar year 1920 was \$441,369,660. This total is taken from a compilation just made by the Bureau of Internal Revenue. The total number of manufacturing chemical concerns which made returns to the Bureau of Internal Revenue was 5,826. Of that number 2,779 reported no net income. The total deficit reported by those concerns was \$96,439,756.

The 3,047 concerns reporting net income paid taxes to the extent of \$98,163,376.

The concerns engaged in manufacturing chemicals proper which made returns in 1920 numbered 908. Of these, 516 reported net incomes aggregating \$42,034,248. They paid taxes to the extent of \$9,823,369. The remaining 392 concerns reported no net income, with deficits of \$7,919,341.

PAINTS AND OILS

The Revenue Bureau figures show that 648 concerns engaged in the manufacture of paints and varnishes made returns. Of that number 438 reported net incomes aggregating \$17,371,134. The tax paid by these concerns totaled \$3,688,282. The remaining 210 concerns reported no net income, with deficits totaling \$3,154,247.

There were 457 concerns engaged in the preparation of vegetable and animal oils. Of that number 156 reported net incomes aggregating \$1,272,359. They paid taxes to the amount of \$3,820,496. The remaining 301 concerns reported no net income, with deficits totaling \$12,455,527.

PETROLEUM AND REFINING

Petroleum and mineral oil refining is included under the chemical activities. Those concerns numbered 390. Of that number 203 reported net incomes aggregating \$245,599,730. The tax collected from those companies totaled \$54,554,347. The remaining 187 concerns reported no net income, with deficits totaling \$4,570,838.

SOAP

Soap-manufacturing concerns making returns numbered 157. Of that number 63 reported net incomes totaling \$3,657,175. They paid taxes amounting to \$632,501. The remaining 94 concerns reported no net income, with deficits totaling \$14,798,185.

FERTILIZERS

Two hundred and thirty concerns engaged in the manufacture of fertilizers made returns in 1920. Of that number 107 reported net incomes totaling \$5,480,826. Their total tax bill was \$885,771. The remaining 123 concerns reported no net income, with deficits totaling \$25,788,478.

The bureau classifies returns from

2,036 as manufacturers of "all other chemicals and allied substances." Of that number 1,564 reported net incomes totaling \$111,768,470. They paid taxes to the extent of \$24,758,610. The remaining 1,472 concerns reported no net income, with \$27,753,740 deficits.

Bureau of Mines Completes Fluorspar Investigation

Accurate information on methods of mining, milling and utilization and on costs of production of fluorspar is so lacking that it has been considered advisable by the Bureau of Mines to investigate all phases of the fluorspar industry in the United States. At the request of and in company with several Eastern fluorspar producers, examination has been made of the principal fluorspar deposits of the Western states. This examination was followed by an intensive study of the producing mines in Illinois and Kentucky. It was found that most of the deposits in the Far Western states were small and could not be relied on to produce much surplus over the needs of the Western states. Costs of production in the Illinois-Kentucky field have increased greatly, owing to the increasing depth of the principal mines, the large amount of water that must be pumped and the increased costs of labor and supplies. A report on all phases of the fluorspar industry is in preparation.

Pacific Coast Steel Plants Consolidate, Planning Expansion

The Pacific Steel Corporation, San Francisco, Calif., recently organized to take over and consolidate the Pacific Coast Steel Co., the Southern California Iron & Steel Co. and the Milner Corp., is perfecting plans for immediate enlargement in the different plants of the affiliated interests, estimated to cost in excess of \$7,000,000. The Pacific Coast company has plants at San Francisco, Portland and Seattle. All of these will be extended with new buildings and equipment, including practically a doubling of the present capacity at the San Francisco works. The Southern California company has going plants at Los Angeles and San Diego, both of which will be enlarged in the near future.

Prospective plans provide for the early erection of a new blast furnace on site to be selected in Utah, estimated to cost approximately \$5,000,000. It will be devoted to the production of pig iron, which will be utilized at the different steel mills of the company. The new corporation proposes to arrange facilities for the complete manufacture of fabricated steel shapes and other steel products from raw materials on the Pacific coast. It is capitalized at \$20,000,000, with 200,000 shares of common stock, no par value. Organization plans and the election of officers and directors are now being consummated. The company is represented by T. T. C. Gregory, attorney, Insurance Exchange Building, San Francisco.

Agricultural Chemists to Meet in Washington

Variety of Food and Drug Products to Be Discussed at Annual Convention

The thirty-eighth annual convention of the Association of Official Agricultural Chemists will be held in Washington, D. C., at the Raleigh Hotel, beginning Nov. 15.

The morning session, the first day of the meeting, will include discussions on the general subjects of water, tanning, insecticides, soils and food products. That afternoon symposiums will be held on fertilizers, dairy products, baking powder, fats and oils and inorganic plant constituents. The drug section will meet at the same time and twenty-one papers on the preparation, analysis and properties of various drugs are scheduled.

The Thursday sessions will be devoted to papers on foods, food preservatives and the testing of food products. Vinegars, flavoring extracts, gelatine, tea, coffee, spices, cereal foods and beverages will come in for a share of the discussion.

Harvey W. Wiley, honorary president of the association, will address the meeting Thursday morning at 11 o'clock. F. P. Veitch, president of the association, will also speak at this time and will introduce Senator E. F. Ladd, who is tentatively scheduled for a talk. Secretary of Agriculture Wallace is on the Thursday afternoon program.

Friday will be devoted to committee reports, fourteen reports being expected.

Electric Welding by Alternating Current

A system of electric arc welding using an alternating current, the invention of A. Tornblom, a Swedish engineer, has been placed on the market by Carlson-Hedborg-deVerdier, Stockholm, under the trade name "Wex system." Use of the alternating current in electric welding is an important feature in view of the fact that most shops use this current. The rheostat is designed to keep the current continuously at even strength. An economic advantage is that welding may be made with a comparatively weak current. Thus it requires only 3.6 kw.-hr. to melt 1 kg. of iron.

Fertilizers Given Transportation Priority by I.C.C.

By including fertilizers among the commodities given priority in transportation in its service order 25, the Interstate Commerce Commission has given official recognition for the first time to the essential character of the fertilizer industry. The effect of service order 25 has been to relieve very greatly the situation which for a time made it impossible to move fertilizers in anything like the volume necessary to meet the country's requirements. The situation was aggravated by the seasonal character of this movement.

Safety Institute of America Plans Accident Prevention Week

More than 6,000 industrial plants in New York City employing nearly one million men and women will participate in the campaign for the prevention of accidents which will be launched during the week of Oct. 8 to 14 by the Safety Institute of America through the Public Safety Committee, of which Elbert H. Gary is chairman. This announcement was made by Laurence Vail Coleman, director of the Safety Institute of America, following the appointment of Henry D. Sayer, Commissioner of the New York State Department of Labor, as chairman of the industrial committee for the safety week campaign.

In urging the industries to conduct a safety campaign within their own plants, the Institute believes that it is reaching effectively not only workmen but fathers and citizens, thus making a direct contribution to the campaign.

Commissioner Sayer is asking each of the 3,000 plants under the jurisdiction of his department to conduct a safety drive within its own gates throughout safety week, to hold mass meetings of employees which will be addressed by safety speakers and at which in many cases safety motion pictures will be shown. Each plant has been requested to post at each entrance and on bulletin boards throughout the plant the "Don't Get Hurt" posters issued by the Safety Institute.

Big Australian Power Project Progressing Rapidly

Electrification of the State of Victoria, Australia, by the utilization of the Morwell brown coal is being rapidly carried forward by the State Electricity Commission, according to reports to the Department of Commerce.

The main power house, which is to be situated at the new township of Yallourn, about 5 miles from Morwell, and which is expected to be in operation in about 2 years' time, will have an initial capacity of 50,000 kw. and will contain five 12,500 turbo-generators. All the principal contracts for the plant and machinery for the main power station at Yallourn are being placed, and the reports indicate that the progress with the manufacture of the machinery is good. A considerable portion of the equipment has already been delivered, while the manufacture of the five turbo-alternators and of the condensing plant is well advanced.

The greater part of the preparatory work of the site has been completed; contractors for the steel work for the power station are at work on the ground and steel is arriving. Gangs have been organized for the erection of the transmission line (over a distance of 112 miles) for which much of the material is now at hand.

The erection of the auxiliary station at Newport is proceeding satisfactorily and justifies the expectation that the station will be in operation by May, 1923, as originally intended.

Pottery Firms Indicted

(Continued from page 709)

Arthur Plantier, Sr., president and general manager of the Sanitary Earthenware Specialty Co., Trenton, N. J.

George C. Kalbfleisch, factory manager of the Standard Sanitary Manufacturing Co., Kokomo, Ind.

Sigmund B. Kling, factory manager of the Standard Sanitary Manufacturing Co., Tiffin, Ohio.

Willard C. Chamberlain, sales manager of the Standard Sanitary Manufacturing Co.

Elzey S. Aitkin, general manager of the Trenton Potteries Co., Trenton, N. J.

J. E. Wright, president and general manager of the Wheeling Sanitary Manufacturing Co.

Chris Horton, president and treasurer of the Horton Pottery Co., Chillicothe, Ohio.

Surplus Picric Acid in Demand for State Roads

Over 4,000,000 lb. of the War Department's surplus picric acid has been distributed to date through the Bureau of Public Roads. All orders received from states have been filled as follows: California, 72,400 lb.; Connecticut, 20,400; Georgia, 37,800; Idaho, 135,100; Indiana, 24,000; Iowa, 57,300; Kansas, 16,100; Louisiana, 37,300; Michigan, 804,800; Minnesota, 1,133,300; Mississippi, 23,000; Missouri, 65,000; Montana, 35,200; New York, 100; North Carolina, 117,200; Ohio, 42,000; South Carolina, 17,100; Tennessee, 81,100; Washington, 72,600; Wisconsin, 1,456,800, and Vermont, 3,200.

Personal

Dr. JAMES C. ANDREWS has severed his connection with E. I. du Pont de Nemours & Co. in order to teach physiological chemistry in the medical school of the University of Pennsylvania, Philadelphia, Pa.

GEORGE A. BOLE has been appointed superintendent of the ceramic experiment station of the Bureau of Mines at Columbus, Ohio. For the past 5 months Mr. Bole has been acting superintendent of the station. Mr. Bole joined the Bureau of Mines staff on Aug. 6, 1921, as an associate chemist. For 9 years prior to that time he had been professor of ceramic chemistry at Alfred University. He was graduated from Geneva College in 1906 and from Columbia University in 1911.

RICHARD H. EURICH, formerly with the Westinghouse Electric & Manufacturing Co., Trafford, Pa., is now vice-president and works manager of the Morristown Electric Steel Foundry, Morristown, N. J.

LEON W. PARSONS has tendered his official resignation as assistant director of the Research Laboratory of Applied Chemistry and assistant professor of

applied chemical research of the Massachusetts Institute of Technology, to take effect Nov. 1, in order to accept the position of chief chemist with the Tide Water Oil Co. His headquarters will be at Bayonne, N. J.

Dr. ROBERT E. SWAIN, head of the department of chemistry at Stanford University, spoke before the Southern California Section of the American Chemical Society, Sept. 28, on "Some Aspects of the Smoke Problem."

ROBERT C. WEED, formerly metallurgist for Fairbanks, Morse & Co., is now with the Minnesota Steel Co., Duluth, Minn.

W. B. WIEGLAND has recently been appointed general manager of the reorganized Ames-Holden McCready, Ltd., a wholesale rubber goods concern of Montreal. Mr. Wiegand has been an executive of the company during the past 3 years.

The following have joined the staff of the research laboratory of the Eastman Kodak Co., Rochester, N. Y.: Dr. Helge Schibsted, formerly with the Atmospheric Nitrogen Co.; Clyde Brockett, Massachusetts Institute of Technology, 1922; Alasco Burgess, Bates College, 1922; D. Henry Harris, Massachusetts Institute of Technology, 1922; Roger P. Loveland, Grinnell College, 1919.

The Massachusetts Institute of Technology, Cambridge, Mass., in preparation for the opening of its new academic year on Oct. 2, announces a number of additions to its faculty and instructing staff. Chief among these are the appointments of W. Spencer Hutchinson to the professorship of mining, Dr. G. B. Waterhouse to the professorship of metallurgy and Dr. Frederick G. Keyes to be acting head of the department of chemistry. Professor Hutchinson was graduated from the Institute in 1892 after having studied in the civil engineering and mining departments. Professor Waterhouse was born in England 40 years ago and was educated at Sheffield, where he received the degree of Bachelor of Metallurgy. He came to the United States in 1900 and later studied at Columbia University, where he obtained the degree of Doctor of Philosophy in 1906. Professor Keyes, the present acting head of the department of chemistry, is a graduate of Rhode Island State College and of Brown University. At the latter institution he received the degree of Doctor of Philosophy in 1909. In 1920 he first joined the staff of the Institute. From 1913 to 1916 he was chief engineer of the Cooper-Hewitt Co., and in 1916 he returned to the Institute as associate professor of physicochemical research.

Obituary

FRANK M. HAWKINS, who had been actively connected with the Crouse-Hinds Co. for more than 25 years, died recently.

Market Conditions

In Chemical, Metallurgical and Allied Industries

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities
Prevailing Prices and Market Letters From Principal Industrial Centers

Clearing the Way for Business Progress

Settlement of Labor, Tariff and Bonus Issues Removes Obstacles That Have Retarded Improvement—Unemployment Now Non-Existent—Rising Wages and Prices

NOT AT ANY TIME in recent months have fundamental business conditions appeared in a more favorable light. The wreckage of industrial strife has been almost entirely cleared away, the uncertainties of the tariff are definitely ended, the threat of the bonus has been effectively defeated and, finally, the summer lull in production and demand is gradually giving way to the seasonal activity that usually accompanies the fall and winter months. Thus one by one the serious obstacles in the path of the present business revival have been removed, leaving the way clear for the operation of those factors making for progress and improvement.

TARIFF AND BONUS LEGISLATION

From a national viewpoint the President's veto of the bonus bill and the enactment of the new tariff are of most significance to business. The former action, though not entirely unexpected, has had a cheering influence on those who have been appalled by the prospects of a four-billion-dollar drain on the public treasury. The effects of the new tariff are problematical. It will probably yield an annual revenue in the neighborhood of \$400,000,000, but its opponents contend that it will cost more than that in more expensive living conditions and unfavorable reaction on our export trade.

That the industrial situation has improved with the settlement of the strikes goes without saying. Over 600,000 coal miners and 400,000 railway shopmen are back at their jobs and the textile workers' strike in New England has finally ended after 8 months of struggle. There are, however, certain cumulative effects that

must still be accounted for by industry. The tremendous economic losses arising from interruption and disturbance in these basic industries must be paid for in the long run, even though their full effect may not be felt immediately.

COAL AND TRANSPORTATION

Two closely related factors which may yet have a retarding effect on further business expansion are fuel and transportation. Both at present, however, are most encouraging. Normal production at the anthracite mines during the week ended Sept. 23 brought

Unemployment is no longer a factor in the industrial situation. In comparison with 5,506,000 workers out of employment at this time last year, the *Guaranty Survey* estimates that at present only 1,500,000 are seeking work. The Bureau of Labor Statistics has recently reported the volume of employment in 2,595 representative establishments covering 1,249,144 employees in forty-two manufacturing industries. Of this number thirty industries reported increases in the number of persons employed in August as compared with July. The largest increase, 30.6 per cent, was in stamping metal products. Fertilizers showed an increase of 16 per cent and chemicals an increase of 3.2 per cent. The results reported for a few of the more important industries are shown in Table I.

WAGE INCREASES AND INFLATION

The advance of 20 per cent in wages made effective by the U. S. Steel Corporation appears to have been the cue for all other industries to follow suit. It is a very serious question, however, as to whether or not the rising tendency of both prices and wages is to be regarded as a favorable development. There is abundant evidence to indicate that widespread inflation always has its beginnings in just such general move-

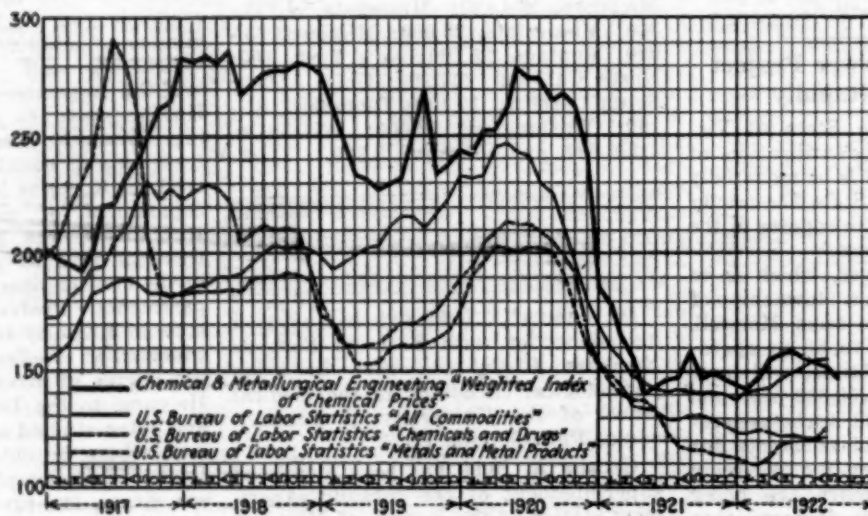


FIG. 1—THE TREND OF CHEMICAL AND METAL PRICES, 1917-1922

the total output of coal, anthracite and bituminous, up to 11,650,000 net tons. Soft coal production of 9,661,000 tons compares with 8,187,000 tons in the corresponding week of 1921 and 10,685,000 tons in 1920. Car loadings, both of coal and other revenue freight, are setting new high records. More cars were loaded during the week which ended Sept. 16 than during any week since Oct. 29, 1921. Coal loadings alone amounted to 172,241 cars, the largest number during any single week since the beginning of the miners' strike. This was an increase of 32,671 cars over the preceding week and 6,730 over the same week of last year.

"Chem. & Met." Weighted Index of Chemical Prices

Base = 100 for 1913-14

This week	150.14
Last week	146.86
October, 1921	151
October, 1920	263
April, 1918 (high)	286
April, 1921 (low)	140

Seven of the twenty-five commodities included in this index advanced in price during the past week. There were no declines. Higher prices were reported for acetic and citric acids, barium chloride, formaldehyde, glycerine, methanol and crude potassium carbonate.

The New York Market

NEW YORK, Oct. 1, 1922.

The new tariff has already shown its effect among imported chemicals and in many instances important advances were recorded. Consumers have changed their conservative methods of trading and it looks as though buyers are gaining confidence in the offerings of leading sellers. Throughout business circles a pronounced spirit of optimism is noted for the last quarter of the year. The tariff has caused a marked increase in citric acid, barium carbonate and chloride, tartaric acid, cream of tartar, prussiate of soda, fluoride of soda, barium nitrate, carbonate of potash, permanganate of potash and various other items. Formaldehyde was advanced 1c. per lb. due to the recent increase in methanol. The recent advance in acetate of lime has been reflected on all grades of acetic acid and acetone. The domestic demand for caustic soda and soda ash has continued very strong at recent levels. Export inquiry is somewhat dormant. Producers of alcohol have increased their prices of the denatured alcohol and methanol. The demand has shown noticeable improvement of late. Glycerine has also shown new advances to 18c. per gal. for the chemically pure in drums. No declines of any importance were recorded during the interval.

GENERAL AND SPECIAL CHEMICALS

Acetic Acid—Prices on all grades have been advanced by producers, due to the higher market on calcium acetate. Commercial 28 per cent is quoted at \$2.80@3.50 per 100 lb. The 56 per cent is held at \$5.60@6.30 per 100 lb. The demand is moderately active.

Acetone—Leading factors have advanced the market on quantity lots to 16½c. per lb. and smaller proportions at 17½c. per pound.

Barium Carbonate—Importers have advanced spot quotations to \$80 per ton. Goods afloat were quoted in several quarters at \$72 per ton in bond. The inquiry is fairly active, although actual transactions were very scarce.

Barium Chloride—Spot prices have been advanced to \$105 per ton. The general tone of this market is very firm with holders not inclined to force any business. Buyers appear eager to purchase at the new levels.

Barium Nitrate—Importers are quoting much higher prices and name 9c. per lb. as the lowest figure on spot. Trading is rather quiet.

Bichromate of Soda—The condition of this market is quite steady, with prominent sellers asking 7½@7¾c. per lb. The consuming inquiry is mostly for small lots.

Carbonate of Potash—Importers are asking much higher prices for this commodity. Spot quotations ranged around 6c. per lb. for the calcined 80-85 per cent. Demand is generally active.

Caustic Soda—Export prices remain quotably unchanged at \$3.55 per 100 lb. for standard brand goods. The domes-

tic demand, however, continues exceedingly active and quite a volume of business is being transacted. Spot goods is quoted at \$3.75@4 per 100 lb. Contract prices remain unchanged.

Chlorate of Potash—Imported material is quoted around 7½@7¾c. per lb. Domestic factors quote 8½c. per lb. f.o.b. works. Demand is moderate.

Cream of Tartar—Leading importers are asking around 26½c. per lb. for spot goods. Buyers were not inclined to purchase at this high level and actual sales were very few.

Formaldehyde—Producers of this material were forced to advance prices due to the sharp advance of methanol. Factors quote 10½c. per lb. for available material in barrels.

Oxalic Acid—Manufacturers quote the market at 16¾c. per lb. f.o.b. works. Odd lots of spot goods have been offered as low as 16¾c. per lb. The general tone has been fairly active, but most sales were for small-lot requirements.

Permanganate of Potash—Spot quotations were advanced considerably and the lowest figure heard was 18c. per lb. U.S.P. crystals.

Prussiate of Soda—Spot goods are being held at higher prices, with sellers naming 24@25c. per lb. Few holders were willing to sell any round lots at the inside figure, as the general feeling among sellers is very bullish. Goods afloat were quoted around 24@24½c. per lb., duty paid. Demand is quite active.

VEGETABLE OILS

Linseed Oil—The market during the past week was rather easy and without any outstanding features. Crushers seemed quite anxious for new business at 88c. per gal., carload lots, on spot. October oil sold down to 85c. per gal. London reported a much higher market for oil, due to the covering of several short sellers. There was no special interest noted among buyers for imported material and the market was merely nominal at 52c. per gal. in bond. Foreign oil on spot held around 85@87c. per gallon.

Coconut Oil—A much better tone was to be noted throughout the past few weeks for all grades. Ceylon grade oil for October shipment from the coast reached 6¾c. per lb., sellers' tanks. Ceylon type for immediate shipment from New York was quoted at 7¾c. per lb., sellers' tanks. Spot goods in barrels ranged around 8½c. per lb. Cochin type oil in barrels held around 8½@9c. per pound.

Peanut Oil—Crude domestic material was somewhat limited to small lots. Recent sales were recorded around 8c. per lb., tank cars, f.o.b. mills. There were no offerings of Oriental peanut oil, due to the new tariff rates. Refined oil on spot was in fair demand at 12@12½c. per lb., in barrels.

Rapeseed Oil—The spot market for refined oil was quite irregular at 78@80c. per gal. Refined oil for shipment was quoted at 74@76c. per gal. The inquiry during the interval was dull.

The Chicago Market

CHICAGO, ILL., Sept. 28, 1922.

The industrial chemical market was very irregular during the past week. Price advances were numerous and holders were very reluctant to dispose of their supplies on quite a few items. Most of the price advances were due to higher duties imposed by the new tariff. Business in general was good, although no large orders from consumers were reported. Speculators were active in securing supplies of several items that were well protected by the new tariff, but their activities had little or no effect on the general condition of the market.

GENERAL CHEMICALS

Caustic soda was apparently in a firm position and supplies were reported to be moving in a good volume to the consuming trade. Prices were firm with the 76 per cent solid quoted in ton lots at \$3.75@3.85 per 100 lb. and the ground or flake at \$4.25. **Caustic potash** was sharply advanced to 7½c. per lb. for the 88-92 per cent material and moved in a good volume. **Soda ash** was unchanged in price at \$2.25 per 100 lb. for the 58 per cent in cooerage and the demand was good. **Sal soda** moved very well at \$1.90 per 100 lb. for moderate lots in barrels.

Potash alum was quoted slightly higher, with a fair demand reported. The iron-free lump was available at 5½@6c. per lb. and the powder at 6½@7c. **Sal ammoniac** was in a firm position and the prime white 98-100 per cent material was quoted at 7½c. per lb. **Barium chloride** was sharply advanced and only small lots were offered at \$125 per ton. **Bleach** was in good demand and was quoted higher at \$2.60 per 100 lb. for spot material. **Copper sulphate** was easy, with supplies plentiful at 6@6½c. per lb. **Carbon bisulphide** continued firm with only moderate supplies offered at 7½c. per lb. **Carbon tetrachloride** was slightly firmer, but the general quotation remained 9c. per lb. for the large drums. **Formaldehyde** was advanced to 10½c. following the advance in methanol and supplies were reported to be light in some quarters. **Furfural** was quoted at 35c. per lb. in 1000-lb. lots. Another advance occurred on **glycerine**, the c.p. material being quoted at 18@18½c. per lb. **Lead acetate** was advanced due to the higher price of acetic acid to 12@13c. per lb. for the white crystals. **Magnesium metal** was quoted higher due to the greater replacement cost. The powdered material was held at \$1.35 per lb. by the principal dealer.

Bichromates were quoted slightly higher, with the potash at 12@13c. per lb. and the soda at 9@9½c. **Potassium permanganate** was in good demand, with only very small supplies available on spot. The U.S.P. crystals were quoted at 19@20c. per lb. **Soda bicarbonate** moved in a fair way to the consuming trade and was unchanged at \$2.25 per 100 lb. **Sodium cyanide** was in fair demand and imported material was quoted at 25c. per lb.

The Iron and Steel Market

PITTSBURGH, Sept. 29, 1922.

Apart from the heavy buying of rails, which is a seasonal movement, the finished steel market is distinctly quiet. In a particular sense the rail buying is the exception that tests the rule, the rail buying having been brought about by the rail mills, apparently, for the purpose of supplying needed reinforcement to order books. The mills announced that, effective at the beginning of October, the rail price would advance from \$40 to \$43 a gross ton, giving the railroads meanwhile an opportunity to buy at the old price, with the stipulation that delivery should be completed by July 1. The railroads have taken hold freely, to profit by the saving, and the total of rails ordered will lie between 1,000,000 and 1,300,000 tons.

CORPORATION AND INDEPENDENT PRICES

Various isolated incidents, viewed together, represent a merging of prices of the Steel Corporation and the independents. Until very lately the two parties were apart on nearly all commodities, the corporation being unable to enter orders for early delivery, while most of the independents could make rather early delivery and obtained what amounted to a delivery premium. In wire products the independents were \$3 a ton above the corporation, while

the corporation has now advanced \$2 and the independents are reducing their prices by the extra dollar. In bars, as indicated above, purchases from some independents can now be made at 2c., while on the other hand the corporation has withdrawn its 1.90c. price on bars, leaving its price at 2c. In shapes there is also a common price of 2c. As to plates, it is doubtful whether at the present time any independent is willing to go as low as 2c., which seems to be the corporation price. Small lots of bars and shapes for very early shipment are bringing above 2c. In the case of pipe there has been no difference between the corporation and the independents except that one independent, able to make relatively early delivery, is asking prices \$2 to \$3 a ton above the regular figures.

In sheets no direct comparison can be made, because the corporation, with a price schedule based on 3.35c. for common black, is sold out until it opens its order books for the first quarter. Independents are getting 3.50c. on most of the tonnage, but mills able to make particularly early deliveries are obtaining up to a 3.75c. basis on small lots. In automobile sheets the disparity is great, much independent tonnage going at 5.25c., against 4.70c. represented in the last sales of the corporation.

Steel production is now at about two-thirds of capacity, having been at close

to three-fourths of capacity in June and having dropped to one-half capacity at the end of August.

While the steel interests have sharply increased their blast-furnace operations in the past 30 days, the merchant furnaces have been unable to do likewise, there being the great difference in position that the steel interests have by-product coke ovens and coal mines, while the merchant furnaces depend chiefly upon purchased Connellsville coke, supplies of which continue very light. Only two or three merchant furnaces in this general territory have resumed.

The pig iron market has been stagnant for several weeks, consumers being apparently unable to pay prices asked, while at best very little tonnage could be obtained by paying one price or another. The Cambria Steel Co., Johnstown, now operating six blast furnaces, has been offering merchant pig iron at prices below the valley basis at points where there is no great freight disparity. It has sold 2,000 tons of basic to a West Virginia sheet interest at \$30 Johnstown, and 1,000 tons of bessemer (silicon 2 to 2.50 per cent) to a Pittsburgh consumer at \$33.50 Johnstown. It is now quoting \$30.50 Johnstown on basic iron, \$32 on malleable and \$32.50 on foundry. Freight Johnstown to Pittsburgh is \$1.77, the same as the valley rate to Pittsburgh.

General Chemicals

Current Wholesale Prices in New York Market

	Carlota F.o.b. N.Y.	Less Carlota F.o.b. N.Y.		Carlota F.o.b. N.Y.	Less Carlota F.o.b. N.Y.
Acetic anhydride.....lb.	—	\$0 38 - \$0 40	Barium dioxide (peroxide).....lb.	.20 - .21	.21 - .22
Acetone.....lb.	\$0 16 - \$0 16	.17 - .17	Barium nitrate.....lb.	.09 - .09	.09 - .10
Acid, acetic, 28 per cent.....100 lbs.	2 80 - 2 90	2 95 - 3 50	Barium sulphate (precip.) (blanc fixe).....lb.	.04 - .04	.04 - .04
Acetic, 56 per cent.....100 lbs.	5 60 - 5 75	5 80 - 6 25	Blanc fixe, dry.....lb.	.04 - .04	—
Acetic, glacial, 99 1/2 per cent, carboys.....100 lbs.	11 60 - 11 25	11 50 - 12 00	Blanc fixe, pulp.....ton	45.00 - 55.00	—
Boric, crystals.....lb.	.11 - .11	.11 - .12	Bleaching powder.....100 lb.	2 00 - 2 10	2 15 - 3 25
Boric, powder.....lb.	.11 - .11	.11 - .12	Blue vitriol (see copper sulphate).....lb.	—	—
Citric.....lb.	—	.50 - .51	Borax.....lb.	.05 - .05	.06 - .06
Hydrochloric.....100 lb.	1 10 - 1 20	1 25 - 1 70	Brimstone (see sulphur, roll).....lb.	.27 - .28	.28 - .35
Hydrofluoric, 52 per cent.....lb.	.11 - .11	.11 - .12	Bromine.....lb.	.27 - .28	.28 - .35
Lactic, 44 per cent tech.....lb.	.09 - .10	.10 - .12	Calcium acetate.....100 lbs.	2 75 - 2 85	2 90 - 3 25
Lactic, 22 per cent tech.....lb.	.04 - .04	.05 - .05	Calcium carbide.....lb.	.04 - .04	.05 - .05
Molybdic, a.p.....lb.	3 00 - 3 25	3 30 - 3 75	Calcium chloride, fused, lump.....ton	22 00 - 23 00	23 50 - 27 00
Muriatic, 20 deg. (see hydrochloric).....lb.	—	—	Calcium chloride, granulated.....lb.	.01 - .01	.02 - .02
Nitric, 40 deg.....lb.	.06 - .06	.06 - .07	Calcium peroxide.....lb.	—	1 40 - 1 50
Nitric, 42 deg.....lb.	.06 - .06	.07 - .07	Calcium phosphate, tribasic.....lb.	—	.15 - .16
Oxalic, crystals.....lb.	.17 - .17	.17 - .18	Camphor.....lb.	.06 - .07	.06 - .08
Phosphoric, 50 per cent solution.....lb.	.07 - .08	.08 - .09	Carbon bisulphide.....lb.	.06 - .07	.07 - .07
Picric.....lb.	.20 - .22	.23 - .27	Carbon tetrachloride, drums.....lb.	.10 - .10	.10 - .12
Pyrogallol, resublimed.....lb.	—	1 65 - 1 75	Carbonyl chloride (phosgene).....lb.	—	.60 - .75
Sulphuric, 60 deg., tank cars.....ton	10 00 - 10 50	—	Caustic potash (see potassium hydroxide).....lb.	—	—
Sulphuric, 60 deg., drums.....ton	12 00 - 14 00	—	Caustic soda (see sodium hydroxide).....lb.	—	—
Sulphuric, 66 deg., tank cars.....ton	15 00 - 16 00	—	Chalk, precip.—domestic, light.....lb.	.04 - .04	—
Sulphuric, 66 deg., drums.....ton	19 00 - 20 00	20 50 - 21 00	Chalk, precip.—domestic, heavy.....lb.	.03 - .03	—
Sulphuric, 66 deg., carboys.....ton	—	—	Chalk, precip.—imported, light.....lb.	.04 - .05	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	19 00 - 20 00	—	Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.05 - .05	.05 - .06
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	22 00 - 22 50	23 00 - 24 00	Chloroform.....lb.	—	.25 - .32
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31 00 - 32 00	33 00 - 34 00	Cobalt oxide.....lb.	—	2 00 - 2 10
Tannic, U. S. P.....lb.	—	.60 - .75	Copperas.....ton	20 00 - 22 00	23 00 - 30 00
Tannic (tech.).....lb.	.40 - .45	.46 - .50	Copper carbonate, green precipitate.....lb.	.20 - .20	.20 - .21
Tartaric, imported crystals.....lb.	—	.31 - .31	Copper cyanide.....lb.	—	.58 - .60
Tartaric acid, imported, powdered.....lb.	—	.31 - .31	Copper sulphate, crystals.....100 lb.	5 75 - 6 00	6 10 - 6 50
Tartaric acid, domestic.....lb.	—	.32 - .32	Cream of tartar.....lb.	—	.26 - .27
Tungstic, per lb. of WO.....lb.	—	1 00 - 1 10	Epsom salt (see magnesium sulphate).....lb.	—	.65 - .70
Alcohol, ethyl (Cologne spirit).....gal.	—	4 75 - 4 95	Ethyl acetate com. 85%.....gal.	—	—
Alcohol, methyl (see methanol).....gal.	—	—	Ethyl acetate, pure (acetic ether, 98% to 100%).....gal.	—	.90 - .95
Alcohol, denatured, 188 proof No. 1.....gal.	—	.36 - .38	Formaldehyde, 40 per cent.....lb.	.10 - .10	.11 - .11
Alcohol, denatured, 188 proof No. 5.....gal.	—	.36 - .38	Fullers earth, f.o.b. mines.....net ton	16 00 - 17 00	—
Alum, ammonia, lump.....lb.	.03 - .03	.03 - .04	Fullers earth—imported powdered—net ton	30 00 - 32 00	—
Alum, potash, lump.....lb.	.03 - .03	.04 - .04	Fusel oil, ref.....gal.	—	2 75 - 2 90
Alum, chrome lump.....lb.	.03 - .03	.05 - .06	Fusel oil, crude.....gal.	—	1 65 - 1 85
Aluminum sulphate, commercial.....100 lb.	1 50 - 1 65	1 70 - 2 25	Glauber's salt (see sodium sulphate).....lb.	—	.18 - .18
Aluminum sulphate, iron free.....lb.	.02 - .02	.03 - .03	Glycerine, a. p. drums extra.....lb.	—	4 40 - 4 50
Aqua ammonia, 26 deg. drums (750 lb.).....lb.	.06 - .07	.07 - .08	Iodine, resublimed.....lb.	—	.12 - .18
Ammonia, anhydrous, cyl (100-150 lb.).....lb.	.30 - .30	.30 - .31	Iron oxide, red.....lb.	—	.10 - .11
Ammonium carbonate, powder.....lb.	.08 - .08	.09 - .09	Lead acetate, white crystals.....lb.	.13 - .13	.13 - .14
Ammonium nitrate.....lb.	.06 - .06	.06 - .07	Lead arsenate, powd.....lb.	—	.15 - .20
Amylacetate tech.....gal.	—	2 35 - 2 50	Lead nitrate.....lb.	.07 - .08	.08 - .09
Arsenic, white, powdered.....lb.	.08 - .09	.09 - .09	Litharge.....lb.	.06 - .06	.06 - .07
Arsenic, red, powdered.....lb.	.12 - .12	.12 - .13	Magnesium carbonate, technical.....lb.	2 00 - 2 25	2 30 - 2 50
Barium carbonate.....ton	80 00 - 82 00	83 00 - 85 00	Magnesium sulphate, U. S. P.....100 lb.	—	1 00 - 1 80
Barium chloride.....ton	105 00 - 107 00	108 00 - 110 00	Magnesium sulphate, technical.....100 lb.	—	.70 - .71
			Methanol, 95%.....gal.	—	.71 - .72
			Methanol, 97%.....gal.	—	.71 - .72
			Nickel salt, double.....lb.	—	.11 - .11

	Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Nickel salt, single..... lb.	12 - 12	12 - 12
Phosgene (see carbonyl chloride)..... lb.	40 - 45	40 - 45
Phosphorus, red..... lb.	30 - 35	30 - 35
Phosphorus, yellow..... lb.	10 - 10	10 - 10
Potassium bichromate..... lb.	17 - 23	17 - 23
Potassium bromide, granular..... lb.	13 - 16	13 - 16
Potassium carbonate, U. S. P..... lb.	06 - 06	06 - 06
Potassium carbonate, 80-85%..... lb.	07 - 07	08 - 08
Potassium chlorate/powdered and crystals..... lb.	55 - 57	55 - 57
Potassium cyanide..... lb.	6.50 - 6.60	6.65 - 7.00
Potassium hydroxide (caustic potash) 100 lb.	06 - 06	3.45 - 3.55
Potassium iodide..... lb.	06 - 06	07 - 08
Potassium nitrate..... lb.	18 - 18	18 - 19
Potassium permanganate..... lb.	95 - 1.00	95 - 1.00
Potassium prussiate, red..... lb.	37 - 37	37 - 38
Potassium prussiate, yellow..... lb.	06 - 07	07 - 07
Rochelle salts (see sodium potas. tartrate)..... lb.	07 - 08	08 - 08
Salammoniac, white, granular..... lb.	1.20 - 1.40	1.45 - 1.60
Salammoniac, gray, granular..... lb.	25.00 - 27.00	25.00 - 27.00
Salt cake (bulk)..... ton	1.60 - 1.67	2.00 - 2.25
Soda ash, light, 58 per cent flat, bags, contract..... 100 lb.	1.75 - 1.80	1.85 - 2.35
Soda ash, light, 58 per cent flat, bags, resale..... 100 lb.	1.85 - 1.90	1.95 - 2.40
Soda ash, dense, in bags, resale..... 100 lb.	08 - 08	08 - 09
Sodium acetate..... 100 lb.	1.75 - 1.85	1.90 - 2.30
Sodium bicarbonate..... 100 lb.	07 - 07	08 - 08
Sodium bichromate..... 100 lb.	4.50 - 4.60	4.65 - 5.50
Sodium bisulphate (nitre cake)..... ton	04 - 04	04 - 05
Sodium bisulphate powdered, U.S.P..... lb.	06 - 06	07 - 07
Sodium chloride..... long ton	12.00 - 13.00	12.00 - 13.00
Sodium chloride..... lb.	19 - 21	21 - 25
Sodium fluoride..... lb.	09 - 09	09 - 10
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract..... 100 lb.	3.35 - 3.40	3.75 - 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale..... 100 lb.	3.60 - 3.65	3.70 - 4.00
Sodium hydroxide (caustic soda), ground and flake, contracts..... 100 lb.	3.80 - 3.90	4.25 - 4.40
Sodium hydroxide (caustic soda) ground and flake, resale..... 100 lb.	4.00 - 4.15	4.40 - 4.60
Sodium hypsulphite..... lb.	02 - 02	03 - 03
Sodium nitrite..... lb.	09 - 09	10 - 10
Sodium peroxide, powdered..... lb.	28 - 30	31 - 35
Sodium phosphate, dibasic..... lb.	03 - 04	04 - 04
Sodium potassium tartrate (Rochelle salt)..... lb.	24 - 24	24 - 24
Sodium prussiate, yellow..... lb.	80 - 1.00	1.05 - 1.25
Sodium silicate, (40 deg. in drums)..... 100 lb.	2.25 - 2.40	2.45 - 2.75
Sodium silicate, (60 deg. in drums)..... 100 lb.	85 - 95	1.00 - 1.40
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	04 - 04	04 - 05
Sodium sulphate, fused, 60-62 per cent (conc.) lb.	03 - 03	03 - 04
Sodium sulphate, crystals..... lb.	09 - 10	10 - 12
Strontium nitrate, powdered..... lb.	04 - 05	05 - 06
Sulphur chloride, yellow..... lb.	18.00 - 20.00	18.00 - 20.00
Sulphur, crude..... ton	08 - 08	09 - 10
Sulphur dioxide, liquid, cylinders extra..... 100 lb.	2.00 - 2.15	2.25 - 3.10
Sulphur (sublimed), flour..... 100 lb.	2.00 - 2.15	2.20 - 2.70
Sulphur, roll (brimstone)..... 100 lb.	30.00 - 40.00	30.00 - 40.00
Tale—imported..... ton	18.00 - 25.00	18.00 - 25.00
Tale—domestic powdered..... ton	10 - 10	10 - 10
Tin bichloride..... lb.	39 - 40	39 - 40
Tin oxide..... lb.	14 - 14	14 - 15
Zinc carbonate..... lb.	06 - 06	06 - 07
Zinc chloride, gran..... lb.	42 - 44	45 - 47
Zinc cyanide..... lb.	07 - 08	08 - 08
Zinc oxide, XX..... lb.	2.75 - 3.00	3.05 - 3.30
Zinc sulphate..... 100 lb.	2.75 - 3.00	3.05 - 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:		
Alpha-naphthol, crude..... lb.	\$0.95 - \$1.00	\$0.95 - \$1.00
Alpha-naphthol, refined..... lb.	1.10 - 1.15	1.10 - 1.15
Alpha-naphthylamine..... lb.	28 - 30	28 - 30
Aniline oil, drums extra..... lb.	15 - 17	15 - 17
Aniline salts..... lb.	22 - 24	22 - 24
Anthracene, 80% in drums (100 lb.)..... lb.	75 - 1.00	75 - 1.00
Fluorene, 80% in drums (100 lb.)..... lb.	1.25 - 1.35	1.25 - 1.35
Fluorene, pure, water-white, in drums (100 gal.)..... gal.	30 - 35	30 - 35
Fluorene, 90% in drums (100 gal.)..... gal.	28 - 32	28 - 32
Benzidine, base..... lb.	85 - 95	85 - 95
Benzidine sulphate..... lb.	80 - 85	80 - 85
Benzidine acid, U.S.P..... lb.	72 - 75	72 - 75
Benzidine of soda, U.S.P..... lb.	57 - 65	57 - 65
Benzyl chloride, 95-97%, refined..... lb.	25 - 27	25 - 27
Benzyl chloride, tech..... lb.	20 - 23	20 - 23
Beta-naphthol benzene..... lb.	3.75 - 4.00	3.75 - 4.00
Beta-naphthol, sublimed..... lb.	51 - 55	51 - 55
Beta-naphthol, tech..... lb.	23 - 25	23 - 25
Beta-naphthylamine, sublimed..... lb.	1.50 - 1.60	1.50 - 1.60
Carbazol..... lb.	75 - 90	75 - 90
Cresol, U. S. P., in drums (100 lb.)..... lb.	12 - 13	12 - 13
Ortho-cresol, in drums (100 lb.)..... lb.	16 - 18	16 - 18
Cresylic acid, 97-99%, straw color, in drums..... gal.	56 - 65	56 - 65
Cresylic acid, 95-97%, dark, in drums..... gal.	51 - 59	51 - 59
Dichlorobenzene..... lb.	06 - 06	06 - 06
Diethylamine..... lb.	50 - 60	50 - 60
Dimethylamine..... lb.	32 - 34	32 - 34
Dinitrobenzene..... lb.	20 - 22	20 - 22
Dinitrochlorobenzene..... lb.	21 - 22	21 - 22
Dinitronaphthalene..... lb.	30 - 32	30 - 32
Dinitrophenol..... lb.	32 - 34	32 - 34
Dinitrotoluene..... lb.	22 - 24	22 - 24
Dip oil, 25% car lots, in drums..... gal.	72 - 75	72 - 75
Diphenylamine..... lb.	54 - 56	54 - 56
H-acid..... lb.	72 - 75	72 - 75
Meta-phenylenediamine..... lb.	90 - 1.00	90 - 1.00
Monochlorobenzene..... lb.	10 - 11	10 - 11
Monooxylamine..... lb.	95 - 1.10	95 - 1.10
Naphthalene crushed, in bbls..... lb.	06 - 06	06 - 06
Naphthalene, flake..... lb.	06 - 07	06 - 07
Naphthalene, balls..... lb.	07 - 08	07 - 08
Naphthalene of soda..... lb.	58 - 65	58 - 65
Naphthalonic acid, crude..... lb.	65 - 70	65 - 70
Nitrobenzene..... lb.	10 - 12	10 - 12
Nitro-naphthalene..... lb.	30 - 35	30 - 35

Nitro-toluene..... lb.	\$0.15 - \$0.10	\$0.15 - \$0.10
N-W acid..... lb.	1.15 - 1.30	1.15 - 1.30
Ortho-amidophenol..... lb.	2.10 - 2.15	2.10 - 2.15
Ortho-dichlorobenzene..... lb.	17 - 20	17 - 20
Ortho-nitro-phenol..... lb.	80 - 85	80 - 85
Ortho-nitro-toluene..... lb.	10 - 13	10 - 13
Ortho-toluidine..... lb.	12 - 14	12 - 14
Para-amidophenol, base..... lb.	1.20 - 1.25	1.20 - 1.25
Para-amidophenol, HCl..... lb.	1.25 - 1.30	1.25 - 1.30
Para-dichlorobenzene..... lb.	17 - 20	17 - 20
Paranitroaniline..... lb.	72 - 80	72 - 80
Para-nitrotoluene..... lb.	55 - 65	55 - 65
Para-phenylenediamine..... lb.	1.55 - 1.60	1.55 - 1.60
Para-toluidine..... lb.	85 - 90	85 - 90
Phthalic anhydride..... lb.	35 - 38	35 - 38
Phenol, U. S. P., drums..... lb.	21 - 22	21 - 22
Pyridine..... gal.	1.75 - 2.75	1.75 - 2.75
Resorcinol, technical..... lb.	1.50 - 1.55	1.50 - 1.55
Resorcinol, pure..... lb.	2.00 - 2.10	2.00 - 2.10
R-salt..... lb.	55 - 60	55 - 60
Salicylic acid, tech., in bbls..... lb.	25 - 27	25 - 27
Salicylic acid, U. S. P..... lb.	29 - 30	29 - 30
Solvent naphtha, water-white, in drums, 100 gal..... gal.	27 - 32	27 - 32
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	12 - 14	12 - 14
Sulphanilic acid, crude..... lb.	24 - 26	24 - 26
Toluidine..... lb.	1.20 - 1.30	1.20 - 1.30
Toluidine, mixed..... lb.	30 - 35	30 - 35
Toluene, in tank cars..... gal.	25 - 28	25 - 28
Toluene, in drums..... gal.	30 - 35	30 - 35
Xylidines, drums, 100 gal..... lb.	40 - 45	40 - 45
Xylene, pure, in drums..... gal.	40 - 45	40 - 45
Xylene, pure, in tank cars..... gal.	45 - 55	45 - 55
Xylene, commercial, in drums, 100 gal..... gal.	33 - 35	33 - 35
Xylene, commercial, in tank cars..... gal.	30 - 35	30 - 35

Waxes

Prices based on original packages in large quantities f.o.b. N.Y.

Bayberry Wax..... lb.	\$0.19 - \$0.20	\$0.19 - \$0.20
Beeswax, refined, dark..... lb.	30 - 32	30 - 32
Beeswax, refined, light..... lb.	34 - 35	34 - 35
Beeswax, pure white..... lb.	36 - 40	36 - 40
Candelilla, wax..... lb.	43 - 45	43 - 45
Carnauba, No. 1..... lb.	40 - 42	40 - 42
Carnauba No. 2, North Country..... lb.	25 - 26	25 - 26
Carnauba, No. 3, North Country..... lb.	19 - 19	19 - 19
Japan..... lb.	15 - 15	15 - 15
Montan, crude..... lb.	03 - 04	03 - 04
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	04 - 04	04 - 04
Paraffine waxes, crude, scale 124-126 m.p..... lb.	02 - 02	02 - 02
Paraffine waxes, refined, 118-120 m.p..... lb.	03 - 03	03 - 03
Paraffine waxes, refined, 125 m.p..... lb.	03 - 03	03 - 03
Paraffine waxes, refined, 128-130 m.p..... lb.	04 - 04	04 - 04
Paraffine waxes, refined, 133-135 m.p..... lb.	04 - 04	04 - 04
Paraffine waxes, refined, 135-137 m.p..... lb.	05 - 05	05 - 05
Stearic acid, single pressed..... lb.	09 - 09	09 - 09
Stearic acid, double pressed..... lb.	09 - 09	09 - 09
Stearic acid, triple pressed..... lb.	10 - 10	10 - 10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$6.60 - \$6.75	\$6.60 - \$6.75
Rosin E-I..... 280 lb.	6.80 - 6.85	6.80 - 6.85
Rosin K-N..... 280 lb.	6.90 - 7.00	6.90 - 7.00
Rosin W. G. W. W..... 280 lb.	7.85 - 8.40	7.85 - 8.40
Wood rosin, bbl..... 280 lb.	6.25 - 6.40	6.25 - 6.40
Spirits of turpentine..... gal.	1.37 - 1.38	1.37 - 1.38
Wood turpentine, steam dist..... gal.	1.15 - 1.15	1.15 - 1.15
Wood turpentine, dest. dist..... gal.	1.12 - 1.12	1.12 - 1.12
Pine tar pitch, bbl..... 200 lb.	6.00 - 6.00	6.00 - 6.00
Tar, kiln burned, bbl. (500 lb.)..... bbl.	9.50 - 9.50	9.50 - 9.50
Retort tar, bbl..... 500 lb.	9.00 - 9.00	9.00 - 9.00
Rosin oil, first run..... gal.	.38 - .38	.38 - .38
Rosin oil, second run..... gal.	.41 - .41	.41 - .41
Rosin oil, third run..... gal.	.48 - .48	.48 - .48
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	1.00 - 1.00	1.00 - 1.00
Pine oil, pure, dest. dist..... gal.	.95 - .95	.95 - .95
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 - .46	.46 - .46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 - .35	.35 - .35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 - .75	.75 - .75
Pine tar, ref., thin, sp.gr. 1.080-1.060..... gal.	.25 - .25	.25 - .25
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.25 - .25	.25 - .25
Pine wood creosote, ref..... gal.	.52 - .52	.52 - .52

Fertilizers

Ammonium sulphate, f.a.s., N. Y., double bags..... 100 lb.	3.75 - 3.80	3.75 - 3.80
Blood, dried, f.o.b., N. Y..... unit	4.60 - 4.60	4.60 - 4.60
Bone, 3 and 50, ground, raw..... ton	42.00 - 44.00	42.00 - 44.00
Fish scrap, dom., dried, f.o.b. works..... unit	3.10 - 3.20	3.10 - 3.20
Nitrate of soda..... 100 lb.	2.40 - 2.45	2.40 - 2.45
Tankage, high grade, f.o.b. Chicago..... unit	4.50 - 4.60	4.50 - 4.60
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%..... ton	3.50 - 4.00	3.50 - 4.00
Tennessee, 78-80%..... ton	7.00 - 8.00	7.00 - 8.00
Potassium muriate, 80%..... ton	33.00 - 34.00	33.00 - 34.00
Potassium sulphate..... unit	1.00 - 1.00	1.00 - 1.00

Crude Rubber

Para—Upriver fine..... lb.	\$0.18 - .19	\$0.18 - .19
Upriver coarse..... lb.	.13 - .14	.13 - .14
Upriver caucho ball..... lb.	.13 - .13	.13 - .13
Plantation—First latex crepe..... lb.	.15 - .15	.15 - .15
Rubbed smoked sheets..... lb.	.15 - .15	.15 - .15
Brown crepe, thin, clean..... lb.	.14 - .14	.14 - .14
Amber crepe No. 1..... lb.	.14 - .14	.14 - .14

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	\$0.12	—	\$0.13
Castor oil, AA, in bbls.	lb.	.13	—	.13
China wood oil, in bbls.	lb.	.12	—	.12
Coconut oil, Ceylon grade, in bbls.	lb.	.08	—	.08
Coconut oil, Ceylon grade, in bbls.	lb.	.08	—	.09
Corn oil, crude, in bbls.	lb.	.11	—	.10
Cottonseed oil, crude (f. o. b. mill)	lb.	.17	—	.0
Cottonseed oil, summer yellow	lb.	.11	—	.11
Cottonseed oil, winter yellow	lb.	.12	—	.12
Linseed oil, raw, car lots (domestic)	gal.	.88	—	.88
Linseed oil, raw, tank cars (domestic)	gal.	.83	—	.84
Linseed oil, boiled, in 5-bbl lots (domestic)	gal.	.90	—	.91
Olive oil, denatured	gal.	1.15	—	1.17
Palm, Lagos	lb.	.06	—	.07
Palm, Niger	lb.	.06	—	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08	—	.08
Peanut oil, refined, in bbls.	lb.	.12	—	.12
Rapeseed oil, refined in bbls.	gal.	.78	—	.80
Rapeseed oil, blown, in bbls.	gal.	.86	—	.87
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11	—	.11
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09	—	.09

FISH

Light pressed menhaden	gal.	\$0.51	—	
White bleached menhaden	gal.	.54	—	.55
Blown menhaden	gal.	.61	—	
Whale Oil, No. 1, crude, tanks, coast	gal.	.45	—	.48

Miscellaneous Materials

All f.o.b. New York, Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	\$700.00	—	\$750.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	65.00	—	100.00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	14.00	—	17.00
Barytes, ground, white, f.o.b. mills	net ton	17.00	—	23.00
Barytes, ground, off color f.o.b. mills	net ton	13.00	—	21.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	—	24.00
Barytes, crude f.o.b. mines	net ton	8.00	—	9.00
Casein	lb.	.10	—	.13
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00	—	8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00	—	9.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00	—	20.00
China clay (kaolin), imported, lump	net ton	16.00	—	20.00
China clay (kaolin), imported, powdered	net ton	30.00	—	35.00
Feldspar, No. 1 pottery grade	long ton	7.00	—	7.50
Feldspar, No. 2 pottery grade	long ton	5.75	—	5.90
Feldspar, No. 1 soap grade	long ton	7.00	—	7.50
Feldspar, No. 1 Canadian, for mill	long ton	21.00	—	22.00
Graphite, Ceylon lump, first quality, f.o.b. N. Y.	lb.	.05	—	.05
Graphite, Ceylon chip	lb.	.04	—	.04
Graphite, high grade amorphous crude	ton	35.00	—	53.00
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00	—	
Kieselguhr, f.o.b. N. Y.	per ton	50.00	—	55.00
Magnesite, crude, f.o.b. California mines	per ton	12.00	—	15.00
Pumice stone, imported	lb.	.03	—	.05
Pumice stone, domestic, lump	lb.	.06	—	.07
Pumice stone, domestic, ground	lb.	.06	—	.07
Shells, orange sue	lb.	.63	—	.64
Shells, orange superline	lb.	.65	—	.66
Shells, A. C. garnet	lb.	.65	—	.66
Shells, T. N.	lb.	.58	—	.60
Silica, glass sand, f.o.b. Indiana	per ton	1.50	—	2.50
Silica, sand blast material, f.o.b. Indiana	per ton	2.50	—	5.00
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	16.00	—	16.00
Silica, building sand, f.o.b. Pa.	per ton	2.00	—	2.75
Sopstones	ton	12.00	—	15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00	—	12.00
Talc, 200 mesh, f.o.b. Georgia	ton	7.50	—	12.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	15.00	—	17.00

Refractories

Bauxite brick, 56% Al ₂ O ₃ , f.o.b. Pittsburgh	per 1,000	\$130.00	—	
Chrome brick, f.o.b. Eastern shipping points	net ton	50	—	
Chrome cement, 40-50% Cr ₂ O ₃	net ton	23-27	—	
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points	net ton	23.00	—	
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	35-40	—	
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	26-28	—	
Magnesite brick, 9-in. straight (f.o.b. works)	net ton	60	—	
Magnesite brick, 9-in. arches, wedges and keys	net ton	70	—	
Magnesite brick, soaps and splits	net ton	90	—	
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	48-50	—	
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	50-53	—	
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	45-47	—	
Silicon carbide refractory brick, 9-in.	1,000	1100.00	—	

Ferro-Alloys

Ferrotitanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	\$200.00	—	\$225.00
Ferrocromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.10	—	.10
Ferrocromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.10	—	.11
Ferromanganese, 78-82% Mn, domestic	gross ton	69.00	—	72.00
Spiegelisen, 19-21% Mn	gross ton	38.00	—	39.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	1.85	—	2.00
Ferrosilicon, 10-15%	gross ton	38.00	—	40.00
Ferrosilicon, 50%	gross ton	63.00	—	65.00
Ferrosilicon 75%	gross ton	115.00	—	120.00
Ferrotungsten, 70-80% per lb. of contained W	lb.	.75	—	.80
Ferrotungsten, 35-50% of U per lb. of U content	lb.	6.00	—	
Ferrovandium, 30-40% per lb. of contained V	lb.	3.50	—	4.00

Ores and Semi-finished Products

All f.o.b. New York Unless Otherwise Stated

Bauxite, domestic, crushed and dried, f.o.b. shipping points	net ton	\$6.00	—	\$9.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard	ton	19.00	—	20.00
Coke, foundry, f.o.b. ovens	net ton	13.50	—	14.00
Coke, furnace, f.o.b. ovens	net ton	12.00	—	12.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	15.00	—	
Fluorspar, standard, domestic washed gravel	net ton	17.50	—	19.00
Kentucky and Illinois mines	lb.	.01	—	.01
Ilmenite, 52% TiO ₂ , per lb. ore	unit	.43	—	
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	net ton	70.00	—	75.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.	lb.	.80	—	.85
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport	unit	27.00	—	
Pyrites, Spanish, fines, c.i.f. Atlantic seaport	unit	.10	—	.11
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.12	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	Nominal	—	
Rutile, 95% TiO ₂ per lb. ore	lb.	.12	—	
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal)	unit	7.00	—	7.25
Tungsten, wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.	unit	6.75	—	7.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained	lb.	1.00	—	
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04	—	.13

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

Copper, electrolytic		Cents per Lb
Aluminum, 98 to 99 per cent		14.00
Antimony, wholesale lots, Chinese and Japanese		19.50-20.00
Nickel, ordinary (ingot)		7.00-7.25
Nickel, electrolytic		36.00
Nickel, electrolytic, resale		39.00
Nickel, ingot and shot, resale		32.00-33.00
Monel metal shot and blooms		30.00-31.00
Monel metal ingots		32.00
Monel metal, sheet bars		35.00
Tin, 5-ton lots, Straits		38.00
Lead, New York, spot		32.375
Lead, E. St. Louis, spot		6.35-6.50
Zinc, spot, New York		6.25
Zinc, spot, E. St. Louis		7.15-7.20
		6.875

OTHER METALS

Silver (commercial)	oz.	\$0.691
Cadmium	lb.	1.15
Bismuth (500 lb. lots)	lb.	2.30
Cobalt	lb.	3.00@3.25
Magnesium, ingots, 99 per cent	lb.	1.00@1.05
Platinum	oz.	\$118.00
Iridium	oz.	2.75@3.00
Palladium	oz.	55.00
Mercury	75 lb.	72.00

FINISHED METAL PRODUCTS

		Warehouse Price Cents per Lb.
Copper sheets, hot rolled		20.00
Copper bottoms		30.00
Copper rods		19.75
High brass wire		18.75
High brass rods		16.75
Low brass wire		19.60
Low brass rods		20.25
Brazed brass tubing		23.00
Brazed bronze tubing		28.00
Seamless copper tubing		24.75
Seamless high brass tubing		22.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

Copper, heavy and crucible		11.00@11.25
Copper, heavy and wire		10.50@10.75
Copper, light and bottoms		8.50@8.75
Lead, heavy		4.50@4.75
Lead, ten		3.25@3.50
Brass, heavy		5.50@5.75
Brass, light		5.00@5.25
No. 1 yellow brass turnings		5.50@5.75
Zinc		2.25@2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1 in. and larger, and plates 1 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Chicago
Structural shapes	\$2.90	\$2.90
Soft steel bars	2.80	2.80
Soft steel bar shapes	2.80	2.80
Soft steel bands	3.40	3.40
Plates, 1 to 1 in. thick	2.90	2.90

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

AJO—The New Cornelia Mining Co. has awarded a contract to the Wisconsin Bridge Co. for the erection of the building for its proposed concentrating and flotation plant, and will arrange a list of equipment for installation at an early date, to include ore crushers, conveyors, electric equipment and other operating machinery in addition to primary concentrating machinery. The plant is estimated to cost in excess of \$2,500,000.

California

LONG BEACH—The Pacific Petroleum Products Co., Los Angeles, is selecting a local site for the construction of a new refinery, to be used primarily for the production of gasoline. L. C. Monks heads the company.

LOS ANGELES—The Mathews Paint Co. has plans under way for the construction of a new 1-story plant, 50x170 ft., on the San Fernando Road, near Ave. 26, to cost about \$17,000. The Moran Co., 206 Kerckhoff Bldg., is architect.

VISALIA—The Kaweah Lime Products Co. has plans under way for the construction of an addition to its plant at Terminus, near Visalia, to cost about \$25,000. A. C. Root is general manager.

LOS ANGELES—The Downing Process Laboratories, Inc., 6363 Santa Monica Blvd., is having plans prepared for the construction of two 2-story additions, 40x60 ft. and 32x50 ft. respectively. Edward T. Flaherty, 435 I. W. Hellman Bldg., is engineer.

Connecticut

ROCKY HILL—The Connecticut Foundry, Inc., has awarded a contract to C. P. Waterman, Inc., 43 Framingham Ave., Hartford, for the construction of a 1-story foundry addition, about 20x42 ft.

Delaware

WILMINGTON—A 2-story foundry, 98x240 ft., will be constructed at once at the plant of the Hilles & Jones Division of the Consolidated Machine Tool Corp., 9th and Church Sts., estimated to cost about \$40,000.

District of Columbia

LANGDON—The Fleischmann Co., 701 Washington St., New York, N. Y., has awarded a contract to the Schneider-Spleidt Co., Washington, D. C., for extensions and improvements in its local 3-story yeast-manufacturing plant, to cost about \$50,000.

Illinois

EAST ALTON—The Western Cartridge Co. is completing plans for the construction of a 1-story addition to its brass mill, 86x240 ft., estimated to cost approximately \$50,000.

Louisiana

MONROE—The Monroe Glass Co., recently organized with a capital of \$25,000, has plans under way for the establishment of a new local plant for the manufacture of lamp chimneys and other blown glass products. John Hartman, Alexandria, La., is vice-president.

Maine

MONTAGUE—The International Paper Co., 30 Broad St., New York, N. Y., is reported to be planning for the rebuilding of the portion of its local pulp mill, destroyed by fire Sept. 5, with loss estimated in excess of \$50,000.

Maryland

BALTIMORE—The Solarine Co., Emerson Bldg., manufacturer of metal polishes, will take bids at once for the construction of its proposed new 1-story plant, 100x150 ft., on Eagle St., estimated to cost about \$75,000,

including equipment. E. H. Glidden, American Bldg., is architect.

BALTIMORE—The Baltimore Steel Co., Eastern Ave., has plans under way for the construction of an addition to its plant, on property adjoining the present works, recently acquired, estimated to cost approximately \$250,000, including equipment.

BALTIMORE—The Toledo Bottle Cap Co., Toledo, O., manufacturer of paper bottle caps and kindred specialties, has leased space in the Chandler Bldg., comprising about 6,000 sq. ft., and will soon commence the installation of machinery for a new branch plant.

Massachusetts

FITCHBURG—The Crocker Burbank Co., Westminster St., manufacturer of paper products, will commence the immediate construction of a 2-story mill addition, 45x90 ft. The general building contract has been let to Wiley & Foss, Central St.

MALDEN—Wadsworth, Howland & Co., Inc., 139 Federal St., Boston, has awarded a contract to William Daniels, 161 Exchange St., Worcester, Mass., for the construction of a new 5-story building, 52x190 ft., at Malden, to be used in connection with its general line of paint and varnish manufacture.

SALEM—Baker & Kimball, 28 South St., Boston, have acquired property at 5 Fort Ave., Salem, 70x175 ft., and have plans in preparation for the construction of a 2-story plant on the site, to be used for the manufacture of leather products.

Michigan

KALAMAZOO—The Bryant Paper Co. has plans under way for the construction of two new plant buildings, and enlargement of a number of plant departments for considerable increase in production. The work will include a 1-story machine shop, and new power plant. A bond issue of \$5,000,000 is being arranged, a portion of the fund to be used for the expansion.

New Jersey

OLD BRIDGE—The Ceramics Products Corp., recently organized with a capital of \$200,000, has acquired the local plant of the Brookfield Glass Co., comprising a number of buildings on a tract of 150 acres of land, with considerable equipment previously used by the former owner, for glass and pottery manufacture. Plans are under way for a number of improvements in the plant, and operations will be commenced at an early date, giving employment to about 200 persons. The new company is headed by Gerald M. McLaughlin and T. Bryant Smith.

LAMBERTVILLE—The Lambertville Rubber Co. is planning for enlargements in its plant, to include the establishment of a new department for the manufacture of different rubber specialties. It is purposed to increase the working force by about 50 operatives.

TRENTON—The Economy Pottery Co., Bunting Ave., manufacturer of sanitary earthenware, has filed plans for the construction of a 1-story addition.

BAYONNE—The Standard Oil Co., 26 Broadway, New York, N. Y., has commenced excavations for the construction of a new 3-story building, 80x100 ft., at its local oil works, estimated to cost about \$75,000.

TRENTON—The Murray Rubber Co. is being organized to take over and operate the plant of the Empire Tire & Rubber Corp., North Clinton and Mulberry Sts., recently acquired at a receiver's sale by William M. Pepper and associates for a consideration of \$1,675,000. The new company plans for the immediate resumption of operations at the plant, and will soon commence the installation of machinery for enlargements in a number of departments. C. Edward Murray, Jr., is president and general manager. Mr. Pepper is vice-president and treasurer.

TRENTON—Fire, Sept. 19, damaged a portion of the plant of the Mercer Pottery Co., Muirhead Ave., manufacturer of chinaware products. The loss, including power plant and damage to the main 4-story pottery, has not been officially estimated.

New York

NORTH HOOSICK—The Stevens & Thompson Paper Co., operating a local mill, with branch plants at Walloomsac and Greenwich, N. Y., will make enlargements at the two last noted mills to increase the capacity from 85 to 100 tons per day. The company is also arranging for extensive operations at the plant of a subsidiary organization at Bloomfield, N. J. To provide for the expansion, a bond issue of \$1,000,000 has been arranged. Frank L. Stevens is president.

ROCHESTER—The Don-o-Lac Co., manufacturer of paints, varnishes, etc., is considering the rebuilding of the portion of its local plant, destroyed by fire, Sept. 18, with loss estimated at about \$60,000.

NEW YORK—The Braden Copper Co., 120 Broadway, is arranging an appropriation of \$1,500,000 for the construction of an addition to its copper mill, to increase the capacity from 10,000 to 15,000 tons of ore per day. The company is a subsidiary of the Kennecott Copper Corp., same address.

North Carolina

GREENSBORO—City Manager P. C. Painter is taking bids until Oct. 10 for the construction of a new filtration plant with capacity of 6,000,000 gal. The Ludlow Engineers, Inc., Winston-Salem, N. C., is engineer.

HILTON—Fire, Sept. 18, destroyed a portion of the acid works of the American Cotton Oil Co., with loss estimated at about \$25,000. It is planned to rebuild.

Ohio

LANCASTER—The Fairfield Glass Co., manufacturer of window glass, has plans nearing completion for the construction of a new plant, to consist of a number of buildings, estimated to cost close to \$2,500,000, including machinery. The De Vore Co., 903 Nicholas Bldg., Toledo, O., is architect and engineer. Leopold Mambourg is vice-president and general manager.

MINERVA—The Owen China Co. has awarded a general contract to W. A. Rabold, 804 Columbus Ave., N. W., Canton, O., for the construction of a new 1-story pottery, on local site, 165x196 ft., estimated to cost approximately \$175,000, including equipment. C. W. Foreman is president.

Oklahoma

OKLAHOMA CITY—The North American Oil Co., recently organized under Delaware laws with capital of \$35,000,000, has tentative plans under consideration for extensions and improvements in the oil refineries of a number of companies lately consolidated. The properties of the new company include the Noco Petroleum Co., the Noco Mexican Oil Co. and the Noco Pipe Line Co., all of Oklahoma City; the Black Petroleum Corp., Okmulgee, Okla.; the Puritan Petroleum Co., Lesh Refining Corp., Lesh Oil Products Co. and the Petroleum Transit Co. all of New York. C. F. Colhord heads the new organization.

OKLAHOMA CITY—The Goltzhorpe Oil Refining Co., including refinery and equipment, has been acquired by George Smith and associates. The new owners plan for enlargements and improvements in the plant, to include the installation of additional equipment.

Pennsylvania

BOYERTOWN—The Eastern Foundry Co. will soon take bids for the construction of a new 1- and 2-story foundry addition, 100x150 ft. A. S. Keptner, 121 Hanover St., Pottstown, Pa., is architect. E. M. Rhoads is president of the company.

KUTZTOWN—The Reading Rubber Co., Reading, Pa., has acquired the local plant of Jacob K. Boyer, heretofore devoted to box manufacturing, and will remodel and improve the works for the establishment of a new plant for the manufacture of rubber tubes for automobile service. Machinery to cost close to \$25,000, will be installed.

PHILADELPHIA—The West Philadelphia Cut Glass Co., 5920 Baltimore St., has taken bids and will soon commence the construction of a new plant at Redfield and Baltimore Sts. Emile G. Perrot, Boyertown Bldg., is architect.

PITTSBURGH—The Hanlon-Gregory Galvanizing Co., 24th St. and the Allegheny Valley Railroad, is completing plans for the construction of a new 1-story plant at 56th and Butler Sts., 100x400 ft., to be used for the manufacture of galvanized metal products. It will cost about \$100,000. J. R. Dwyer, Forbes-Murray Bldg., is architect.

HARRISBURG—The Robcond Co., VanWert, O., manufacturer of cement-stucco products, has work under way on a new plant at

Lucknow, near Harrisburg. It will be 1-story, 50x300 ft. H. S. Webster and O. E. Thompson, formerly located at the VanWert plant, will be in charge at the new local works.

PITTSBURGH—The Ball Chemical Co., Fulton Bldg., has awarded a contract to the Williams & Haas Co., Empire Bldg., for the construction of a new building at Whitmar Station, to cost about \$25,000.

Texas

PORT ARTHUR—The Gulf Refining Co. has preliminary negotiations under way for the purchase of a tract of about 100 acres of land, to be used as a site for the construction of an addition to its local refinery. The new plant will operate under an aluminum-chloride process of gasoline separation from crude oil, and is estimated to cost close to \$500,000. George H. Tabor is vice-president.

DAMON—The Union Sulphur Co., Sulphur, La., has acquired a tract of local land, comprising about 215 acres, to be used as a site for the construction of a new plant. The works will consist of a number of buildings, including machine shop, power house, etc., and will be supplemented with a housing development for employees. It is expected to require close to 24 months for the completion, with estimated cost close to \$5,000,000.

DALLAS—The Southwestern Paper Co. is completing plans and will soon commence the construction of a new building on Lacy St. near Young St. George L. Thompkins is general manager.

GALVESTON—The Galveston Gas Co. will build an addition to its artificial gas plant at 32nd St. and Ave. D, estimated to cost close to \$100,000. It will have a capacity of 100,000 cu ft. per hour. Paul E. Nichol is general manager.

DALLAS—The Garvey Vinegar Co. has plans in preparation for the establishment of a new local plant for the manufacture of vinegar products, with initial capacity of about 25,000 gal. per month. Thomas Garvey is head.

West Virginia

WHEELING—The Wheeling Mantle & Tile Co., 829 Market St., has awarded a general contract to George A. Reed, Wheeling, for the construction of a new 1-story plant, estimated to cost about \$15,000.

WHEELING—A 1-story foundry, 100x320 ft., estimated to cost about \$40,000, will be constructed on Warwood Ave., by the Centre Foundry & Machine Co., 2011 Main St., estimated to cost about \$40,000. It will be used for the production of steel castings. The general contract has been let to the Riverside Bridge Co., Martins Ferry, O. J. H. Young is general manager.

Industrial Developments

GLASS—The Ruth-Hastings Glass Co., Conshohocken, Pa., manufacturer of bottles, vials and other hollow ware, is arranging for the immediate resumption of operations at its plant, after an idleness of more than 2 years.

The Twin City Glass Co., Texarkana, Tex., manufacturer of blown glass ware, has resumed operations at its local plant, following a curtailment for some time past. Employment will be given to about 300 men. A wage increase of 5 per cent has recently been granted.

The Elk Run Window Glass Co., Punxsutawney, Pa., has resumed operations at its local plant, after a shut-down for several months past.

The F. L. Freas Glass Works, Conshohocken, Pa., specializing in the production of chemists' glassware and kindred glass products, is running full at its local plant, giving employment to the regular working force. The company is said to have orders on hand for considerable advanced production.

T. C. Weaton & Co., Millville, N. J., have resumed operations at one of their bottle plants, following a shut-down of about 6 weeks.

The Whitall-Tatum Co. has commenced production at two glass plants at its South Millville, N. J. works, following a suspension of several weeks past.

The Noble Glass Co., Conshohocken, Pa., manufacturer of small bottles, vials, etc., is operating at regular capacity with normal working force, and is said to have orders on hand to insure this basis of production for some time to come.

The Millville Bottle Works, Inc., Millville, N. J., has resumed operations at one of its furnaces, following a suspension for more than a month past.

LEATHER—The Pearse Leather Corp., Peabody, Mass., has adopted a full-capacity working schedule at its local tannery, with an overtime shift in a number of departments.

The General Leather Co., Newark, N. J., is operating at full capacity for the production of leather for automobile service, and is said to have orders on hand to insure this basis of production for an indefinite period.

V. & F. W. Filoon & Co., Brockton, Mass., has inaugurated an overtime working schedule at its local tanneries, averaging about 4 hours a day.

The DeFord Co., Baltimore, Md., is operating at full capacity at its leather tannery at Luray, Va. The Covington, Va., plant of the company is said to be running on a curtailed basis, with plans to advance production at an early date.

The Empire Tanning Co., Big Run, near DuBois, Pa., is arranging to close its local plant early in October for an indefinite period. It has been operating on a half-time working basis for a number of months past, and orders on hand will be transferred to other plants of the company. The tannery has been giving employment to about 80 men.

The Fred Rueping Leather Co., Fond du Lac, Wis., is operating at full capacity, giving employment to a regular working force.

J. S. Barnett & Sons, Inc., Lynn, Mass., has adopted a capacity schedule at its local tannery, with employment of normal working force.

PAPER—The D. M. Bare Paper Co., Altoona, Pa., is running at full capacity at its mills at Roaring Springs, near Altoona, giving employment to about 400 operatives. A wage advance of 25 cents a day has been placed into effect.

The Belgo-Canadian Paper Co., Shawinigan, Que., is operating at full capacity at its local paper mills, with employment of maximum working force. The company has plans in progress to double the capacity of the present plant.

The Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., is running full at its local paper mills. A wage advance of 10 per cent, averaging from 3 to 5 cents an hour has recently been granted.

IRON AND STEEL—The American Swedo Iron Co., Danville, Pa., has resumed operations at its local plant, following an idleness for a number of months past. The plant will give employment to about 75 men under full production. The company is said to have orders on hand for about six months to come.

The Punxsutawney Furnace Co., Punxsutawney, Pa., has commenced production at its local plant, following a suspension of operations for more than a year and a half past. It is planned to employ a full working force for an indefinite period.

The Bethlehem Steel Corp. is arranging for the immediate resumption at its Reading, Pa., rolling mill, which has been idle since early in 1921. The works will give employment to about 100 men for initial production, and this number will be increased gradually until a full working force is reached.

The Jones & Laughlin Steel Co., Pittsburgh, Pa., is advancing production at its blast furnaces, and is now running at 75 per cent of normal.

The Struthers Furnace Co., Struthers, O., will blow in its local blast furnace at once, after a suspension of operations for about 20 months past.

The American Sheet & Tin Plate Co., Farrell, Pa., is developing capacity production at its local sheet mill for the first time in a number of weeks past. Arrangements are being perfected for the resumption of operations at the Aetna Standard plant at Pittsburgh, Pa. The company is advancing production at its Sharon, Pa., works, and has recently advanced wages 10 per cent at this plant.

The Illinois Steel Co., Chicago, Ill., has increased production to about 65 per cent of capacity at its mills, and plans for a further advance at an early date.

The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., is arranging to blow in its No. 1 blast furnace within the next few weeks, making ten furnaces in service at the Alabama mills of the company. The No. 1 unit has a capacity of 550 tons per day.

The Hanna Furnace Co. has arranged for the blowing in of its blast furnace at Dover, O., following a suspension since last August. Employment will be given to about 100 men.

The Lockhart Iron & Steel Co. of Pitts-

burgh has started operations at the recently acquired plant of the Sligo Iron & Steel Co. at Connellsville, Pa. The plant has been reconstructed and furnished with up-to-date equipment for the production of muck bars, which will be shipped to the McKees Rocks plant for finishing. Twenty puddling furnaces are now operating, with a capacity of 22,000 tons a year. The plant employs 100 puddlers.

MISCELLANEOUS—The Keystone Tire & Rubber Co. has placed its new plant unit at Kingsbridge, N. Y., in operation on a full-capacity basis.

The Lee Tire & Rubber Co., Conshohocken, Pa., has advanced production at its plant, and is now running on a full day and night schedule.

The Austin Mfg. Co., Wilkes-Barre, Pa., recently organized to manufacture chemical products, has opened a local plant and will operate on a full capacity basis for an indefinite period.

The St. Louis Coke & Chemical Co., a subsidiary of the National Enameling & Stamping Co., is operating its battery of 80 process coke ovens at Granite City, Ill., at full capacity. The parent organization has resumed operations at 14 additional sheet mills at its local plant, and all departments are now running full.

New Companies

THE B. C. TILLINGHAST RUBBER MFG. CO., Jersey City, N. J., care of the Corporation Trust Co., 15 Exchange Place, representative, has been incorporated with a capital of \$50,000, to manufacture rubber products. The principal incorporator is B. C. Tillinghast.

THE ANGELES SNOWOLINE REFINING CO., Los Angeles, Calif., care of G. A. McElroy, 510 West 6th St., representative, has been incorporated with a capital of \$200,000, to manufacture refined petroleum products. The incorporators are F. E. Snowden, W. P. Rhodes and K. M. Doan, all of Los Angeles.

THE C. L. SANFORD BRICK CO., Southold (Suffolk County), N. Y., care of G. C. Terry, Southold, representative, has been incorporated with a capital of \$60,000, to manufacture brick and other burned clay products. The incorporators are C. L. L. N. and F. S. Sanford.

THE CLASON CHEMICAL CORP., Brooklyn, N. Y., care of the Delaware Registration & Incorporators' Co., Ford Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with capital of \$1,000,000, to manufacture chemicals and chemical byproducts. The incorporators are Marcus Bassell and Samuel Zimmerman, both of New York.

THE ALUMINUM PRODUCTS CO., Boston, Mass., has been incorporated with a capital of \$25,000, to manufacture aluminum and kindred metal products. Ralph L. Dodge is president, and John A. Carpenter, 6 Brigham Ave., Waverly, Mass., treasurer. The last noted represents the company.

THE ENAMELING MFG. CO., 549 West Fulton St., Chicago, Ill., has been incorporated with a capital of \$15,000, to manufacture enamelware products. The incorporators are James D. White, Edward R. Mills and Herbert C. Moore.

THE REDWOOD OIL & REFINING CO., Cross Plains, Tex., has been incorporated with a capital of \$250,000, to manufacture refined petroleum products. The incorporators are C. T. Pledger, J. H. Montgomery and R. B. Forbes.

THE UTILITY COLOR & CHEMICAL CO., Newark, N. J., has been incorporated with a capital of \$100,000, to manufacture chemicals and affiliated products. The incorporators are M. M. Williams, Jacob S. Lasky and Louis Schneider, Kinney Bldg., Newark. The last noted represents the company.

THE ATHENIA CHEMICAL CO., Hartford, Conn., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are George Drossinos and Henry Brenner, 150 Governor St., Hartford.

THE INTER-CONTINENT OIL CO., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with a capital of \$5,000,000, to manufacture petroleum products.

THE RUMO CHEMICAL CO., New York, N. Y., care of M. G. Cutler, 42 West 39th St., representative, has been incorporated with a capital of \$5,000, to manufacture chemicals and kindred products. The incorporators are P. Trachtenberg, G. Rosenberg and D. W. Gregory.

THE MIDDLESEX REFINING CO., Middletown, Conn., has been incorporated with a

capital of \$50,000, to manufacture soaps, fat byproducts and kindred specialties. The incorporators are S. S. and Jacob Mattes, 151 Church St., Middletown.

THE BRIGHTON ELECTRIC STEEL CASTING Co., Beaver Falls, Pa., has been incorporated with a capital of \$25,000, to manufacture steel and other metal castings. The incorporators are W. D. Fox, New Brighton, Pa.; Fred Dewhirst and Earl D. Townsend, Beaver Falls. The last noted is treasurer and represents the company.

THE AMERICAN CHEMICAL GAS Co., Philadelphia, Pa., care of the Corporation Guarantee & Trust Co., Land Title Bldg., representative, has been incorporated with a capital of \$1,500,000, to manufacture special chemicals and chemical byproducts.

THE SUPERIOR PORCELAIN PRODUCTS Co., 138 North La Salle St., Chicago, Ill., has been incorporated with a capital of \$5,000, to manufacture porcelain specialties and kindred ceramic products. The incorporators are G. J. David and James H. Davis.

THE CRYSTAL PRODUCTS CORP., Newark, N. J., care of David N. Popik, 790 Broad St., representative, has been incorporated with a capital of \$50,000, to manufacture chemicals, alkalies, etc. The incorporators are Karl J. and Bernard W. Von Smuda, and Abraham Shapiro.

THE METHOLAM PRODUCTS CORP., Brooklyn, N. Y., care of Maxwell Lustig, 154 Nassau St., New York, N. Y., representative, has been incorporated with a capital of \$50,000, to manufacture chemicals and affiliated products. The incorporators are V. P. Mehta, J. O. Olsen and C. G. Dutemple.

THE CONSOLIDATED BRICK Co., Melrose, Mass., has been incorporated with a capital of \$98,000, to manufacture brick and other burned clay products. George L. Baldwin is president, and James E. Frazer, 24 Natalie Ave., treasurer. The last noted represents the company.

THE GENERAL TESTING LABORATORIES, INC., 525 Woodward Ave., Detroit, Mich., has been incorporated with a capital of \$6,000, to manufacture chemicals, chemical compounds, etc. The incorporators are Paul H. Kramer, Charles L. Mann and Joseph A. Wolf.

THE CHINA FIBRE CONTAINER Co., care of the Corporation Trust Co. of America, due Pont Bldg., Wilmington, Del., has been incorporated under Delaware laws with capital of \$250,000, to manufacture fiber products.

THE DAYTON BRICK Co., Dayton, O., has been incorporated with a capital of \$200,000, to manufacture brick and other burned clay products. The incorporators are Lincoln L. Davis and John M. Mulford, both of Dayton.

THE POMPTON IRON Co., 745 East 23rd St., Paterson, N. J., has been incorporated with a capital of \$250,000, to manufacture pig iron. It is proposed to operate a blast furnace in the state. The incorporators are Halsey M. Search, J. Fred Weller and Arthur Search.

THE HAMILTON INTERNATIONAL PULP & LUMBER Co., New York, N. Y., care of the United States Corporation Co., 65 Cedar St., New York, has been incorporated under Delaware laws with capital of \$2,500,000, to manufacture pulp and paper products.

THE PEAVEY RUBBER Co. OF NEW ENGLAND, Boston, Mass., has been incorporated with a capital of \$40,000, to manufacture and deal in rubber products. Ralph A. Peavey is president and treasurer, 101 Homer St., Newton, Mass.

THE NATIONAL OIL Co., Long Beach, Cal., care of Guy F. Rice, Ocean Park, Cal., representative, has been incorporated with a capital of \$250,000, to manufacture petroleum products. The incorporators are F. N. and J. L. F. Cosby, and Paul J. Wessel, Long Beach.

THE NEW JERSEY METAL SALTS Co., Bayway and South Front Sts., Elizabeth, N. J., has been incorporated with a capital of 200 shares of stock, no par value, to manufacture metal salts, chemical specialties, etc. The incorporators are J. Alvin Van Bergh, Donald C. Strachan and Albert L. Florillo.

THE TENNESSEE CHEMICAL Co., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with a capital of \$1,000,000, to manufacture chemicals and chemical byproducts.

THE ATHENS OIL Co., Athens, Tex., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are J. F. Gilmore, W. G. Crumpler and J. M. Hardaway, all of Athens. The same incorporators have also organized the Kaufman Oil Co., Kaufman, Tex., with like capitalization, to manufacture a similar line of products.

Industrial Notes

A. DAIGER & Co. announce that an erroneous report has been circulated regarding a fire which started on their premises at 54 E. Kinzie St., Chicago, Ill. The fire referred to occurred in the block in which the premises of A. Daiger & Co. are located, but no damage occurred to the property of A. Daiger & Co., who were fortunately spared any suffering on this account. They are doing business without any interruption whatsoever and are in excellent position to give immediate, efficient and satisfactory service.

JOHNS-MANVILLE, INC., in order to afford better service to clients, has been appointed joint selling agent by the H. H. Robertson Co. In the future all asbestos-protected metal roofing, siding, accessories and ventilators will be manufactured and shipped from the plant of the H. H. Robertson Co. at Ambridge, near Pittsburgh, Pa. Hereafter, in the manufacture of asbestos-protected metal produced by the H. H. Robertson Co., Johns-Manville asbestos saturated felts will be used, thus affording to the customer both the advantages of the experience of Johns-Manville, Inc., in the manufacture of saturated asbestos felts and the experience of the H. H. Robertson Co. in the fabricating of the finished product.

THE AMERICAN AGRICULTURAL CHEMICAL Co., New York City, at a recent directors' meeting, elected the following officers: Chairman of the board, Robert S. Bradley; president, George B. Burton; vice-presidents, Royall Vistor, Horace Bowker and J. D. C. Bradley; treasurer, Arthur P. Stemm; secretary, J. A. Starrett.

THE BROWN INSTRUMENT Co., Philadelphia, Pa., announces the opening of a Southern branch at 619 Brown-Marx Bldg., Birmingham, Ala., in charge of Charles L. Saunders, and a New England branch at 185 Devonshire St., Boston, Mass., in charge of George Goodman.

M. F. KING, formerly of the Kings Refractories Co., has joined the sales and service department of the Quigley Furnace Specialties Co. Mr. King brings to the Quigley organization the benefit of his wide experience in the application of refractories and high-temperature cements and will devote his attention to service and sales work in New York City.

THE POWER SPECIALTY Co., New York, announces the appointment of Pell W. Foster, Jr., as New England district manager, with offices at 50 Congress St., Boston. Mr. Foster was formerly in the New York sales office.

THE MUELLER ELECTRIC Co. announces the completion of its new building at 1583 East 31st St., Cleveland, where it will continue in a larger way to manufacture electric specialties.

THE CHICAGO FLEXIBLE SHAFT Co. has opened a new district sales office with headquarters in Indianapolis for the handling of furnace sales and Stewart engineering service in southern Indiana, southern Ohio and western West Virginia. F. W. Odemar is in charge of this office and the address is 305 Merchants Bank Bldg.

THE H. K. FERGUSON Co., engineer and builder, Cleveland, O., has elected Jos. S. Rubie vice-president in charge of all construction. Mr. Rubie resigned recently as vice-president of the Austin Co., which position he has held for the past 9 years.

Manufacturers' Catalogs

THE ALLIS-CHALMERS MFG. Co., Milwaukee, Wis., in Bulletin 1821, illustrates and describes Rod Mills.

THE YARNELL-WARING Co., Philadelphia, Pa., has published Bulletin T-1701, describing Yarway steam traps recently developed and placed on the market.

THE LEWIS SEARING Co. OF MICHIGAN, Detroit, Mich., has issued a booklet on "Eight Common Grease Cup Troubles Eliminated."

THE REDMANOL CHEMICAL PRODUCTS Co., Chicago, Ill., has issued an attractive booklet, descriptive of Redmanol products. The booklet tells what Redmanol is, its strength, list of products made from Redmanol, how to mold, etc.

THE ARMSTRONG MACHINE WORKS, Three Rivers, Mich., has published a booklet—Catalog C—on "Armstrong Steam Trap," which gives a description of the operation, application and construction of the traps.

THE ZELLER LACQUER MFG. Co., New York City, has published a booklet, "250 Lacquer Questions Answered," which it is

distributing to all who write for it on business stationery, or otherwise identify themselves. This is the first time that anything of this comprehensive nature has been published. It is presented in question and answer form, practically every problem confronting the lacquer user being answered.

THE PHILADELPHIA GEAR WORKS, Philadelphia, Pa., has issued a catalog and price list which shows an increase in the company's standard stock gears and a still greater increase in its facilities for making gears.

THE ESTERLINE-ANGUS Co., Indianapolis, Ind., has issued Bulletin 722, on the graphic wattmeter.

THE U. S. GALVANIZING & PLATING EQUIPMENT CORP., Brooklyn, N. Y., has issued newly revised bulletins on U. S. Moving Cathode Plating Apparatus (for plating or electrogalvanizing) and U. S. Automatic Cleaning, Pickling, Acid Dip, Neutralizing, Rinsing, Drying and Allied Equipment, Bulletins 100 and 105, respectively.

THE VINELAND SCIENTIFIC GLASS Co., Vineland, N. J., has issued a booklet on Glassware Facts, including machine made homeopathic vials, ampoules, radio tubes (for crystal detector sets), oil cup glasses and test tubes.

THE ARMSTRONG CORK & INSULATION Co., Pittsburgh, Pa., has issued a small folder on "A Neglected Source of Economy," which deals with the savings that can be effected in manufacturing plants by the use of refrigerated drinking water systems.

THE DURIRON Co., INC., Dayton, O., calls attention to Bulletin 128-A, just issued, describing the latest Duriron centrifugal pump Series 102.

Coming Meetings and Events

AMERICAN GAS ASSOCIATION will hold its annual convention and exhibition at Atlantic City, Oct. 23 to 28.

AMERICAN SOCIETY FOR STEEL TREATING is holding its International Steel Exposition and Convention in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN WELDING SOCIETY is holding its fall meeting Oct. 2 to 5 at Chicago.

INTERNATIONAL CHAMBER OF COMMERCE will hold its second general meeting in Rome, Italy, March 19-26, 1923.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month. The first meeting of the fall season will be held on Oct. 9.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a 3-day national convention in New York, beginning Oct. 18. The general topic of the convention is "Economics of Industry."

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting Oct. 9 and 10, at the Hotel Wolverine, Detroit, Mich.

The following meetings are scheduled to be held in Rumford Hall, Chemists' Club, 52 East 41st St., New York City: Oct. 6—American Chemical Society, regular meeting Oct. 13—Société de Chimie Industrielle, regular meeting. Oct. 20—Society of Chemical Industry, Grasselli Medal. Nov. 10—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting. Nov. 17—American Electrochemical Society, regular meeting. Dec. 8—American Chemical Society, regular meeting. Jan. 5—American Chemical Society, regular meeting. Jan. 12—Society of Chemical Industry, Perkin Medal. Feb. 9—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting. March 9—American Chemical Society, Nichols Medal. March 23—Society of Chemical Industry, regular meeting. April 20—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting. May 4—American Chemical Society, regular meeting. May 11—Société de Chimie Industrielle (in charge), American Chemical Society, American Electrochemical Society, Society of Chemical Industry, joint meeting. May 18—Society of Chemical Industry, regular meeting. June 8—American Chemical Society, regular meeting.